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The Weightage of Environmental Elements for Malaysia State Green Road Index of Rural Area

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ABSTRACT

"Green road" is a concept introduced to meet the requirements of economic, societal, and environmental aspects in road construction and its operation. Towards the responsive efforts of sustainable development, many countries had established their environmentally friendly green road assessment tools including for highways and roads. However, the application of the tools is somehow limited to specific project life cycle such for design and planning assessment and/or only for the higher cluster of the road such as toll road or federal highway, but rarely focus on road in rural area. This paper therefore aims to identify the appropriate environmental criteria and elements as proposal for Malaysia State Road Index for the rural area. The weightage of environmental elements for the Malaysia State Road Index for the rural area was established in the discussion of this paper. The environmental criteria and elements were reviewed via critical literature review of content analysis were of 'green tools'. The confirmation of weightage was conducted via questionnaires development and responded by the focus group discussion (FGD) and validation survey. The FGD were the experts involved in road infrastructure development. The data is analysed using the Statistical Package for the Social Sciences (SPSS) software. This study discovered ten sub-criteria and thirty-three elements under 'green road' of significant environmental sustainability elements. The result showcases a fair distribution of weightage for each element within their sub-criteria.

Keywords: Green roads; green tools; environmental sustainability; criteria; weightage

INTRODUCTION

Many developments on highway and road networks causal to the loss of natural scenic beauty area's along highways and roadways. Undoubtedly, the highway and road development sacrificing the existing surrounding nature, and in the context of history, the historical value of the area may disappear. It is observed that many developments deteriorate the current natural landscape. However, with redeveloped landscape, it is hardly to maintain many valuable natural and historical areas (Jaal and Abdullah 2012). Between 2010 and 2015 alone, Malaysia's road network increased 58 percent in order to providing accessibility, mobility, and connectivity that accelerated the growth of cities as well as urban and rural areas (Malaysia Sustainable Development Goals Voluntary National Review, 2017). Since road construction in Malaysia is growing, the use of green road tools is vital for the developers to consider the environmental sustainability. In other words, to achieve green road development, a sustainable principles approach of road construction needs to be applied at every stage of the road project life-cycle that indirectly minimizes adverse impacts on the environment.

In response to the importance of sustainable development, various initiatives have been taken by the Malaysian government and private sectors to support the mandate of Sustainable Development Goals 2030 (SDG 2030). To response to green highway, several researchers, highway experts, and organizations, including the Malaysian Highway Authority (MHA), have successfully produced the Manual of Malaysian Green Highway Index (MyGHI) (Seng 2018).

This indicates that green construction practices in road construction are valuable to them. Other than MHA, the Public Works Department (JKR) also supports green development by issuing the Penarafan Hijau JKR (phJKR) to measure the green level of federal buildings and roads (Adzar J.A et al. 2019). However, most of Malaysia's green road initiatives have their limitation, either focusing on toll highways or only federal roads. Despite this, there is a big doubt on environmental impacts on rural roads as most of them are still under state roads.

According to the Public Work Department (JKR) Malaysia, in the year 2018, Malaysia's road network covers 237,022.353 km. From the entire road network, Federal roads consist of 17,949.731 km length and another 2,000.880 km, is a highway network—the other 217,071.742 km of the network contributing for state roads. The data shows that 90% of Malaysia's road network falls under the state road

category, contributing to the most significant proportion of the network in Malaysia (Adzar J.A et al. 2019). These roads are categorized into four main categories; main federal roads, Felda federal roads, federal roads to an institution, and federal roads to the industrial area. State roads are defined as a road system in every state in Malaysia where respective states funded the road maintenance. Therefore, every road construction, including State roads, should preserve green guidelines such as federal roads with phJKR for green road recognition. Table 1 shows no green tools of State Road, representing the largest network of a road in Malaysia that needs to be to think and realize.

TABLE 1. Road Category and Rating Tools

No	Road Category	Length	Green Tools
1	Highway	2,000.880 km	MyGHI
2	Federal Road	17,949.731 km	pH JKR (Jalan)
3	State Road	217,071.742 km	None

To claim a certification of green road, the assessment of sustainability elements is required to be used; thus, the green road assessment tool is employed. This tool is used to mitigate the environmental impact as well as achieving sustainability goals. However, there are some limitations to the available green road assessment tools. They are only suitable for a higher-ranked cluster of roads that are only restricted to particular areas. Nonetheless, this tool exists only for evaluation instead of for construction.

Meanwhile, all of the assessment tools differ in terms of their distribution. The existing phJKR criteria and sub-criteria may not be suitable for all types of roads based on its current selection criteria, explicitly designed for Federal Road assessment. Despite the criteria being specific, many existing projects are not inclusive of these criteria, resulting in them not adhering to the assessment due to their unsuitability, according to Adzar J.A et al. (2019), results from the cross review on average weightage from other rating system compares to phJKR (Roads) criteria weightage of environment criteria only 4% in the content of Penarafan Hijau JKR (phJKR) which is below average compared to other green tools average was 11%. Although Penarafan Hijau JKR (phJKR) exists as a tool to assess non-toll roads in Malaysia, phJKR (Roads) was found lacking in the content of the environmental element.

Additionally, it is lacking for current available green road tools since the environmental elements are not relevant to all phases of project lifecycles, such as road planning and design, construction, and operation and maintenance. Table 2 portrays environmental criteria found in most extensive scope of green tools that some of them overlap with other elements such as economic, material, and procurement in the sustainability assessment. The environmental criteria in Table 2 below had been taken out from many worldwide green road rating tools. Hence, it is essential to investigate the environment's elements with a significant weightage for green road assessment.

Therefore, the cross-reference of major elements under environmental criteria had been conducted in this study to current available green road tools. Thus, there is also a need to examine all relevant environmental elements from existing green tools and find synchronicity among the elements to identify the environmental standard elements for evaluation. The analysis lead to the outcome of new criteria suitable for the environmental elements for the Malaysia Green State Road Index of the rural area.

TABLE 2. Environmental Elements in Various Infrastructure Green Rating Tools

Rating System	Year	Organization	Characteristic
Leadership in Energy and Environmental Design (LEED)	1998	US Green Building Council (USGBC)	*7 Criteria Categories:* Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation in Design, Regional Priority
Green Leadership In Transportation Environmental Sustainability (GreenLITES)	2008	New York State Department of Transportation	*5 Criteria Categories:* Sustainable Sites, Water Quality, Material Resources, Atmosphere, Innovation
Sustainable Sites Initiative (SITES)	2009	American Society of Landscape Architects	*9 Criteria Categories:* Site selection, Pre-design assessment and planning, Site design-water, Site design-soil and vegetation, Site design-materials selection, Site design-human health, and well-being, Construction Operations and maintenance, Monitoring, Innovation

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BCA Green Mark	2009	Singapore	*7 Criteria Categories:* Landscape, ecology, and land efficiency Energy, Renewable energy, Water Project management, Waste management and environmental protection, Innovation
Greenroad	2010	University of Washington	*7 Criteria Categories:* Basic Project Requirements (Plans), Environment & Water, Access & Equity, Construction Activities, Materials and Resources, Pavement Technologies, Custom Credits
Livable and Sustainable Transportation Rating System and Guide (I- LAST)	2010	Illinois Department of Transportation	*8 Criteria Categories:* Planning, Design, Environmental Water Quality, Transportation, Lighting, Materials, Innovation
Sustainable Transportation Access Rating System (STARS)	2010	Portland (Oregon) Bureau of Transportation;	*5 Criteria Categories ;* Integrated Process, Access, Climate & Energy Ecological Function, Cost Effectiveness Analysis, Innovation
Building Environmentally and Economically Sustainable Transportation Infrastructure- Highways (BE2ST in-Highways)	2010	Recycled Materials Resource Center and University of Wisconsin-Madison	*8 Criteria Categories:* Social Requirements, Regulation Local Ordinances, Greenhouse Gas Emission, Energy Use, Waste Reduction Water Consumption, Social Carbon
Low Carbon Cities Framework (LCCF) v2	2011	Ministry of Energy, Green Technology and Water, KeTTHA	*4 Criteria Categories:* Urban Environment, Urban Transportation, Urban Infrastructure Building
FHWA Infrastructure Voluntary Evaluation Sustainability Tool (INVEST)	2012	Federal Highway Administration	*3 Criteria Categories:* System Planning and Processes, Project Development, Operations and Maintenance
Envision	2012	Institute for Sustainable Infrastructure Ranking System	*5 Criteria Categories:* Quality of Life, Leadership, Resource Allocation, Natural World, Climate and Risk
Greenways	2012	Jackson State University (Mississippi	*5 Criteria Categories:* Materials, Environment/Water, Traffic Efficiency, Lifecycle/Maintenance, Community/Multimodal
pHJKR	2013	Environment and Energy Efficient Division of Public Works Department of Malaysia	*7 Criteria Categories:* Sustainable Site Planning & Management, Environment & Water, Access & Equity, Construction Activities, Material & Resources, Pavement Technologies, Innovation
MyGHI	2014	Universiti Teknologi Malaysia & Malaysian Highway Authority	*5 Criteria Categories:* Sustainable Design and Construction Activities, Energy Efficiency, Environmental and Water Management, Material and Technology, and Social and Safety

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SITES V2	2014	Green Business Certification Inc.	*10 Criteria Categories:* Site Context, : Pre-Design Assessment + Planning, Site Design – Water, 4: Site Design - Soil + Vegetation, Site Design - Materials Selection, Site Design - Human Health + Well-Being, Construction, Operations + Maintenance, Education + Performance Monitoring, Innovation Or Exemplary Performance
CEEQUAL V5.2	2015	Building Research Establishment (BRE) Group, UK	*9 Criteria Categories:* Project/Contract Strategy (optional) Project/Contract Management, People & Communities, Land Use (above & below water) & Landscape, The Historic Environment, Ecology & Biodiversity Water Environment (Fresh & Marine) Physical Resources Use & Management Transport
BREEAM Infrastructure	2015	BREGlobal Limited	*12 Criteria Categories:* Integrated design, Resilience, Stakeholders, Local wellbeing, Transport, Land use and ecology, Landscape and heritage, Pollution, Materials, Carbon and energy, Waste, Water
(Infrastructure Rating Scheme) ISCA v1.2	2016	Infrastructure Sustainability Council of Australia	*7 Criteria Categories:* Management & Governance, Using Resources, Emissions, Pollution & Waste, Ecology, People and Place, Innovation

METHODOLOGY

According to John W. Creswell (2013), the questionnaire design provides a numerical description of a population's trends, attitudes, or opinions by studying a population sample. This study, therefore, used questionnaires to gather information and data. Several steps were taken to design the questionnaires for this study, including survey objectives, determining sample groups, designing questionnaires, administering questionnaires, and interpreting results. Figure 1 shows the methodology flow chart for this research which consist of three phases before achieving the weightage of environmental sub-criteria and elements for the Malaysia State Green Road Index for rural area.

The first phase of the literature review includes identifying the research problem, determining the research title, problem statement, objectives, and scope. A literature review was conducted to gather information about sustainable development, environmental criteria, and green roads. The research problem was identified through intensive review and understand the concept of green roads and current researches or guidelines regarding green roads. 15 standards or green road rating tools and research papers were selected comprehensive in providing green road environmental criteria. The questionnaire method was developed with a given alternatives (5-point Likert scale) for each question. Afterward, a pre-expert discussion with UTM academic staff on the environmental criteria and sub-criteria of road infrastructure has conducted at CREATE JKR on 10-12 February 2019.

The second phase was focused group sitting, internal expert discussion, the study of the questionnaire design concept, and confirmation of template for the questionnaire survey. Firstly, the list was reviewed and analyzed during the briefing session with several road branches under the Public Work Department (JKR). Following that, the semi-structured open-ended questionnaire was created consisting of a list of environmental criteria. After deep discussion of focused group, a decision on the needed data or inputs for this work was taken; the proposed environmental criteria and sub-criteria were identified. Ten sub-criteria and 35 elements were obtained, which should be considered for environmental Criteria in the rural area's Malaysia Green State Road Index.

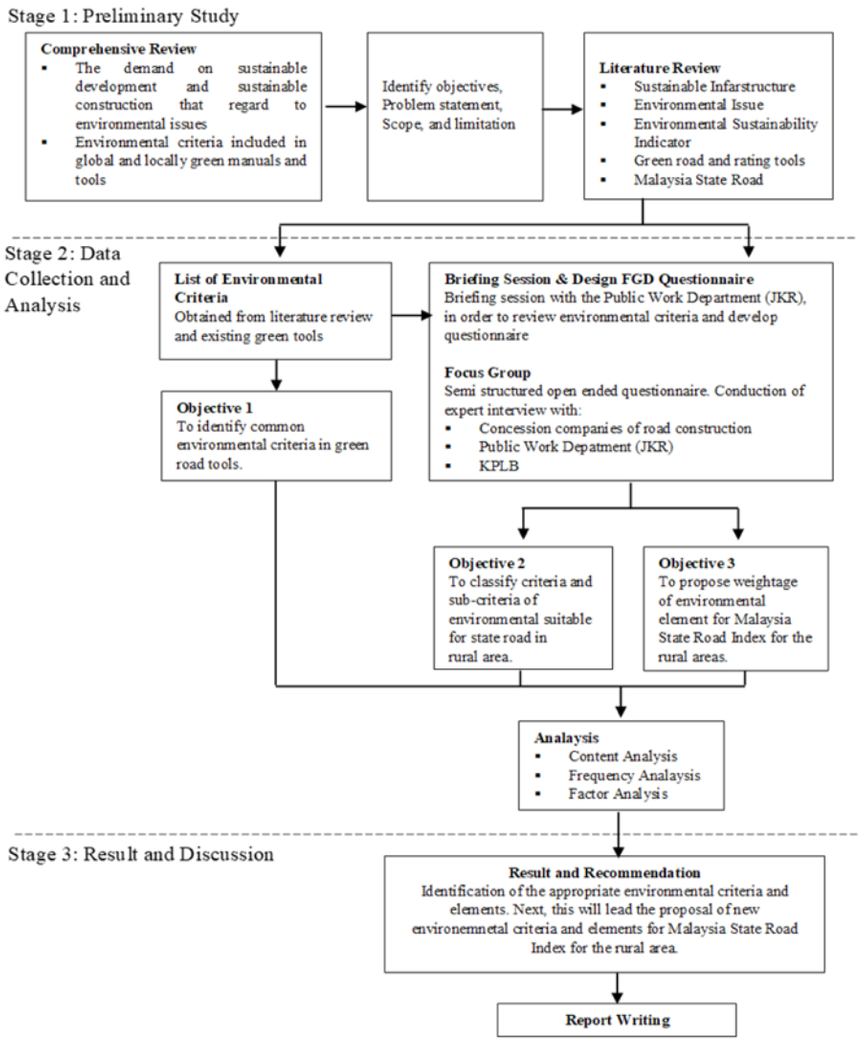

FIGURE 1. Research Flow

Lastly, environmental criteria, sub-criteria, and elements relevant to Malaysian State Green Road Index development in the questionnaire survey template were validated and finalized by experts from concession companies of road construction, Public Work Department (JKR), and Kementerian Pembangunan Luar Bandar during external expert discussion. Subsequently, the questionnaires were distributed at other focus group sessions and conducted in UTM, KL on 25 September 2019, and the rest using the Google Form platform. The total number of respondents involved in this study were 53.

Data analysis started as soon as the relevant data was collected, as presented in the third phase of the research. The data collected were analyzed by using Statistical Package for Social Science (SPSS) software. Reliability test, Average Mean Index, Factor analysis, and Weightage were conducted in these phases of analyses.

RESULT AND DISCUSSION

In order to confirm the criteria and sub-criteria, Factor Analysis was carried out step by step as described in the methodology. Factor Analysis was adopted to prioritized and rank the criteria (Abidin et al. 2017). The reliability test shows that the Cronbach alpha resulted in 0.941. It shows that the alpha coefficient for the 36 variables, indicating high internal consistency for the data set (Rooshdi et al. 2014). From the value of the average index for each element, all elements resulted in above 3.5 and were proceed to undertake the KMO & Bartlett Test. This test aimed to identify whether the criteria are sufficient to conduct factor analysis (De Vaus, 2002). The KMO & Bartlett Test measure of sampling adequacy was 0.510, which is more than 0.5, indicating that the present data were suitable for principal component analysis.

TABLE 3. KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.510
Bartlett's Test of Sphericity	Approx. Chi-Square	2233.570
	df	595
	Sig.	.000

Similarly, Bartlett's test of sphericity was significant ($p < 0.001$), indicating sufficient correlation between the items to proceed with the analysis, as shown in Table 3. The result component matrix is less meaningful than without rotation. The rotated component matrix helps to determine what the components represent. The matrix identifies the items that correlate the highest to one factor and the lowest on the remaining factors.

Varimax rotation was performed, and the component matrix shows factor 1 contains eight items, while factor 2 contains five items, factor 3 contains four items, factor 4 have five items, factor 5 has three items, and factor 6 has four items. Lastly, factors 7 and 8 each have two items. Table 4 shows the rotated component matrix. The result obtained was arrange based on the value of the importance of the criteria.

TABLE 4. Rotated Component Matrix for Environment Criteria

Rotated Component Matrixa								
	Component							
	1	2	3	4	5	6	7	8
Avoid or minimize habitat fragmentation	0.89							
Wildlife habitat restoration	0.86							
Re-plant native plants in reclaimed or abandoned areas	0.84							
Provide wildlife crossing and barriers	0.83							
Protective fencing	0.79							
Tree replacement or relocation	0.71							
Replacing hardscape with softscape (green vegetation)	0.61							
Water pollution reduction	0.5							
Stormwater Management Plan according to MSMA & MS ISO 14001:2015		0.77						
Stormwater Best Management Practice , MSMA & MS ISO 14001:2015		0.74						
Protection of special natural and man made scenery		0.69						
Topsoil preservation and reuse		0.66						
Protection of waterway		0.54						
MS ISO 14001:2015 certification			0.96					
EMS certification			0.93					
Environmental Monitoring Report (EMR);			0.93					
Provision of EPW in contract			0.88					
Using quiet pavement				0.69				
Noise mitigation plan; noise barrier, working hours & etc.				0.69				
Using low decible site equipment				0.68				
Use ultra low sulphur diesel fuel for all non-road diesel equipment				0.67				
Description of noise monitoring standards				0.6				
Implement a preventive maintenance plan for all equipment according to engine manufacturer specifications					0.82			
Establish any policy to reduce emissions of construction equipment					0.8			
Application of techniques to reduce emissions of all on-site diesel engines					0.8			
Provide a designated location to segregate construction waste on-site						0.8		
Provide guidelines for noise limits and controls						0.62		
Create, establish, implement and maintain a formal construction waste						0.56		
Minimize usage of portable water						0.54		
Renewable energy							0.85	
Energy efficiency							0.84	
Recycle the waste								0.73
Proper handling of recyclable (or reusable) materials								0.65

The Factor Loading (FL) for each element were determined from the rotated component matrix table. However, two items were removed due to cross-loadings. Table 5 showed the ranking by factor loading of the sub-criteria and elements of environmental criteria. Thirty-three elements resulted in significant FL, suitable for the environmental criteria of Malaysia State Green Road Index of rural area.

TABLE 5. The Factor Loading of the Sub criteria of Environmental Criteria

Sub criteria	Elements	Rotated Component Matrix								Rank	Elements	Factor Loading (FL)
		1	2	3	4	5	6	7	8			
Environmental Management System (EMS)	EMS certification			0.933						1	MS ISO 14001:2015 certification	0.955
	Provision of EPW in contract			0.878						2	EMS certification	0.933
	MS ISO 14001:2015 certification			0.955						3	Environmental Monitoring Report (EMR); (e.g water/air/noise) in the contract	0.931
	Environmental Monitoring Report (EMR); (e.g water/air/noise) in the contract			0.931						4	Provision of EPW in contract	0.878
Trees and Plants Preservation	Re-plant native plants in reclaimed or abandoned areas	0.843								1	Re-plant native plants in reclaimed or abandoned areas	0.843
	Tree replacement or relocation	0.705								2	Tree replacement or relocation	0.705
	Replacing hardscape with softscape (green vegetation)	0.607								3	Replacing hardscape with softscape (green vegetation)	0.607
Wildlife Protection	Wildlife habitat restoration	0.864								1	Avoid or minimize habitat fragmentation	0.891
	Provide wildlife crossing and barriers	0.834								2	Wildlife habitat restoration	0.864
	Avoid or minimize habitat fragmentation	0.891								3	Provide wildlife crossing and barriers	0.834
	Protective fencing	0.794								4	Protective fencing	0.794
Water Conservation	Water pollution reduction	0.501								1	Stormwater Management Plan according to MSMA & MS ISO 14001:2015	0.773
	Stormwater Best Management Practice according to MSMA & MS ISO 14001:2015		0.737							2	Stormwater Best Management Practice according to MSMA & MS ISO 14001:2015	0.737
	Stormwater Management Plan according to MSMA & MS ISO 14001:2015		0.773							3	Minimize usage of portable water	0.54
	Protection of waterway		0.539							4	Protection of waterway	0.539
	Minimize usage of portable water						0.54			5	Water pollution reduction	0.501
Waste Management Plan	Create, establish, implement and maintain a formal construction waste						0.555			1	Provide a designated location to segregate construction waste on-site	0.799
	Provide a designated location to segregate construction waste on-site						0.799			2	Create, establish, implement and maintain a formal construction waste	0.555
Noise Control	Noise mitigation plan; noise barrier, working hours & etc.				0.694					1	Noise mitigation plan; noise barrier, working hours & etc.	0.694
	Provide guidelines for noise limits and controls						0.617			2	Using quiet pavement	0.694
	Description of noise monitoring standards				0.597					3	Using low decible site equipment	0.684
	Using low decible site equipment				0.684					4	Provide guidelines for noise limits and controls	0.617
	Using quiet pavement				0.694					5	Description of noise monitoring standards	0.597
Air Pollutant & Dust Control	Application of techniques to reduce emissions of all on-site diesel engines					0.795				1	Implement a preventive maintenance plan for all equipment according to engine manufacturer specifications	0.819
	Establish any policy to reduce emissions of construction equipment					0.802				2	Establish any policy to reduce emissions of construction equipment	0.802
	Implement a preventive maintenance plan for all equipment according to engine manufacturer specifications					0.819				3	Application of techniques to reduce emissions of all on-site diesel engines	0.795
	Use ultra low sulphur diesel fuel for all non-road diesel equipment				0.667					4	Use ultra low sulphur diesel fuel for all non-road diesel equipment	0.667
Site Recycling Plan	Recycle the waste								0.725	1	Recycle the waste	0.725
	Proper handling of recyclable (or reusable) materials								0.65	2	Proper handling of recyclable (or reusable) materials	0.65
Innovati	Renewable energy							0.848		1	Renewable energy	0.848
	Energy efficiency							0.838		2	Energy efficiency	0.838
Land	Protection of special natural and man made scenery		0.687							1	Protection of special natural and man made scenery	0.687
	Topsoil preservation and reuse		0.664							2	Topsoil preservation and reuse	0.664

In achieving the weightage, the factor score should be calculated for environmental elements description (Ismail M.A. 2014). The factor score represents the score point for each item, and they were calculated based on factor loading multiply with a mean index. Next, once factor scores were achieved, the weightage was calculated, as showed in Table 6. The total weight of all criteria should be equivalent to 1.000 since the maximum percentages of the stratum in variables are equal to 100%.

TABLE 6. Weightage of Environmental Elements

Sub Criteria	Rank	Elements	Mean	Factor Loading (FL)	Average Mean	Factor Score	Total Factor Score	Weightage	%
Environmental Management System (EMS)	1	MS ISO 14001:2015 certification	4.170	0.955	4.165	3.982	15.400	0.259	25.859
	2	EMS certification	4.150	0.933		3.872		0.251	25.143
	3	Environmental Monitoring Report (EMR); (e.g water/air/noise) in the contract	4.210	0.931		3.920		0.255	25.451
	4	Provision of EPW in contract	4.130	0.878		3.626		0.235	23.546
			4.165			**15.400**		**1.000**	**100.000**
Trees and Plants Preservation	1	Re-plant native plants in reclaimed or abandoned areas	4.110	0.843	4.043	3.465	8.727	0.397	39.702
	2	Tree replacement or relocation	4.020	0.705		2.834		0.325	32.476
	3	Replacing hardscape with softscape (green vegetation)	4.000	0.607		2.428		0.278	27.822
			4.043			**8.727**		**1.000**	**100.000**
Wildlife Protection	1	Avoid or minimize habitat fragmentation	4.040	0.891	4.010	3.600	13.564	0.265	26.538
	2	Wildlife habitat restoration	3.960	0.864		3.421		0.252	25.224
	3	Provide wildlife crossing and barriers	3.980	0.834		3.319		0.245	24.471
	4	Protective fencing	4.060	0.794		3.224		0.238	23.766
			4.010			**13.564**		**1.000**	**100.000**
Water Conservation	1	Stormwater Management Plan according to MSMA & MS ISO 14001:2015	4.250	0.773	4.314	3.285	13.312	0.247	24.678
	2	Stormwater Best Management Practice according to MSMA & MS ISO 14001:2015	4.320	0.737		3.184		0.239	23.916
	3	Minimize usage of portable water	4.260	0.54		2.300		0.173	17.280
	4	Protection of waterway	4.320	0.539		2.328		0.175	17.491
	5	Water pollution reduction	4.420	0.501		2.214		0.166	16.634
			4.314			**13.312**		**1.000**	**100.000**
Waste Management Plan	1	Provide a designated location to segregate construction waste on-site	4.400	0.799	4.400	3.516	5.958	0.590	59.010
	2	Create, establish, implement and maintain a formal construction waste	4.400	0.555		2.442		0.410	40.990
			4.400			**5.958**		**1.000**	**100.000**
Noise Control	1	Noise mitigation plan; noise barrier, working hours & etc.	4.150	0.694	4.062	2.880	13.345	0.216	21.582
	2	Using quiet pavement	3.960	0.694		2.748		0.206	20.594
	3	Using low decible site equipment	4.040	0.684		2.763		0.207	20.707
	4	Provide guidelines for noise limits and controls	4.080	0.617		2.517		0.189	18.864
	5	Description of noise monitoring standards	4.080	0.597		2.436		0.183	18.252
			4.062			**13.345**		**1.000**	**100.000**
Air Pollutant & Dust Control	1	Implement a preventive maintenance plan for all equipment according to engine manufacturer specifications	4.250	0.819	4.105	3.481	12.692	0.274	27.425
	2	Establish any policy to reduce emissions of construction equipment	4.090	0.802		3.280		0.258	25.845
	3	Application of techniques to reduce emissions of all on-site diesel engines	4.230	0.795		3.363		0.265	26.496
	4	Use ultra low sulphur diesel fuel for all non-road diesel equipment	3.850	0.667		2.568		0.202	20.233
			4.105			**12.692**		**1.000**	**100.000**
Site Recycling Plan	1	Recycle the waste	4.170	0.725	4.160	3.023	5.721	0.528	52.847
	2	Proper handling of recyclable (or reusable) materials	4.150	0.65		2.698		0.472	47.153
			4.160			**5.721**		**1.000**	**100.000**
Innovation	1	Renewable energy	3.830	0.848	3.870	3.248	6.524	0.498	49.780
	2	Energy efficiency	3.910	0.838		3.277		0.502	50.220
			3.870			**6.524**		**1.000**	**100.000**
Land	1	Protection of special natural and man made scenery	4.130	0.687	4.105	2.837	5.546	0.512	51.156
	2	Topsoil preservation and reuse	4.080	0.664		2.709		0.488	48.844
			4.105			**5.546**		**1.000**	**100.000**

From the analysis, each of the sub-criteria carries significant importance of the elements which the total Factor score shows Environmental Management System (EMS) is the highest concerned followed by Wildlife protection, Noise Control, Water Conservation, Air Pollution, and Dust Control, Tree and Plants preservation, Innovation, Waste Management Plan, Site Recycling Plan and the least is Land. The highest weightage of the elements is (1) Provide a designated location to segregate construction waste on-site, (2) recycle the waste, (3) Protection of special natural and man-made scenery, (4) energy efficiency, and (5) renewable energy. However, the overall weightage analysis brought fair distribution of each environmental element. Therefore, the implementation of these sub-criteria and elements in the proposed Malaysia State Green Road Index is considered.

CONCLUSION

In conclusion, it is necessary to identify appropriate sub-criteria and environmental elements that can provide an assessment method to assess Malaysia's rural state roads. Thus, it is crucial to figure out the criteria that have been considered in the current green road and highway assessment tools.

Environmental is main criteria would seem to have high consideration in current green rating tools for road in rural area. This is because the identified environmental criteria are the basis in the development of assessment tools by the state government who managing the maintenance of state road in rural area. The criteria can be used as a measurement for improving existing roads and guidelines for the new road to be more environmentally friendly. It is also an established environmental element for state roads in the rural area, contributing to the criteria Malaysia Green State Road Index.

The research findings from this study showed a fair distribution weightage of the sub-criteria and elements of the environment. There were ten sub-criteria and 33 elements that are suitable for environmental criteria. The elements were identified appropriated to be proposed to the rural area's Malaysia Green State Road Index. The road stakeholders have verified this finding in expert discussion related to the framework of the green road index.

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DECLARATION OF COMPETING INTEREST

None

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