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Factors for Implementing Green Highway Concept in Toll Road Development Investment in Indonesia

Muhammad Yunus Asy'Ary[1,*], Christiono Utomo[1]

[1]*Department of Management Technology, Institut Teknologi Sepuluh Nopember, Indonesia*
[*]*Corresponding author: yunus.asyary@gmail.com*

ABSTRACT
One of the national strategy project programs in Indonesia is the development of toll roads in several regions with a public private partnership scheme by cooperating with toll road business entities (BUJT) as investors and developer. With the existence of global environmental issues, the concept of the green highway must also be applied in the development of toll roads in Indonesia. This research is to find out the factors that apply the green highway concept that is significant to investment decisions on toll road development. This research uses a questionnaire survey method and interviews to obtain data based on the perceptions of the toll road developer in Indonesia. Questionnaire questions consist of several aspects of the concept of green highway based on the green highway rating system in toll road development in Indonesia. Based on the result of the survey, there were twenty categories divided into six aspects consisting of water management and drainage, green materials, sustainable sites, energy emissions and waste reduction, social and economic, life-cycle analysis.
Keywords: *toll road development, green highway, green rating, investment.*

1. INTRODUCTION

Construction activities, including road construction, certainly have an impact on the environment, resources, raw materials and people [1]. Research and innovation in construction technology to reduce the negative impact of the development process and construction activities on the environment has been widely carried out, one of which is the green highway concept. Initial research and development of green highway concept technology was first introduced in 2002 in the United States [2]. In the Republic of Indonesia Law No. 2 of 2017 concerning construction services and Presidential Regulation No. 16 of 2018 concerning procurement of goods and services encourage all business actors to carry out green and sustainable construction activities.

A road can be categorized as a green highway if a highway design is based on a relatively new concept and based on several roles of ecological sub-element, landscaping, waste reduction, material, water conservation and energy efficiency so that the highway becomes greener [3]. So, a road design based on the concept of green highway will combine the function of the road with being built with the ecological function around the road. Implementation of construction that applies sustainable practices rather than a modern construction technique, which can maximize the life of the highway can also be said to be a green highway[4]. The use of low pollutant and green materials during road construction is also part of the green highway concept [5].

Green highway rating system can be interpreted as a tool that is used as a reference in a sustainable concept that includes all the processes of road development be it planning, design, construction, operation and maintenance. There are several rating systems that can be used as a reference for categories and indicators, including the Federal Highway Administration (FHWA) rating system, Greenroads, Building Environmentally and Economically Sustainable Transportation (BE2ST), Envision Rating System, GreenLITES (Leadership in Transportation Environmental Sustainability), The Illinois Livable and Sustainable Transportation Rating System and Guide (I-LAST) and Sustainable Transportation and Access Rating System (STARS).

The application of the green highway concept has several obstacles including financial barriers, namely lack of funds for sustainable maintenance, high cost, insufficient information about costs & benefits, lack of funds for the design and implementation process [6]. The drive to apply the green highway concept continues to require the developer to apply the green highway concept to the toll road to be built. The developer needs a basis to decide whether the development of a toll road with a green highway concept is the right decision.

This research aims to identify factors based on the green highway rating system on the application of the green highway concept to investment in toll road development in Indonesia based on the perception of toll road business entities in Indonesia. In this research only comes to the identification of the factors applying the green highway concept based on the green rating system indicators and previous studies. This research uses literature review and survey methods to respondents to get the factors of

applying the green highway concept to investment in toll road development in Indonesia.

2. METHODS

This research consists of 5 phases, in phase 1 is by conducting a literature review from previous research relating to the green highway and green rating system to get the main aspects of implementing green highway. Phase 2 is conducting interviews with toll road construction experts and designers, environmental experts, toll road investors. This is to justify and validate the main aspects that have been obtained from previous literature reviews. Phase 3 is developing a questionnaire based on the main aspects that have been determined and these aspects are elaborated with indicators on the application of the concept of the green highway in investment in toll road development based on literature and the green rating system. These indicators become research variables that are measured using a Likert scale as a measurement scale. Phase 4 is conducting a survey by distributing questionnaires to obtain data on perceptions from toll road business entities regarding the application of the green highway concept to investment in toll road development in Indonesia. A questionnaire distributed to 82 respondents from toll road business entities with a minimum level of manager in the office and field. After that, phase 5 is processing the survey results. The results of the survey questionnaire were then interpreted using descriptive analysis and Cartesian diagrammed to see the position of the variables in the priority quadrant.

2.1 Synthesis

Literature review from previous research related to the green highway is used to determine the main aspects in implementing green highway. The results of the literature review can be shown in table 1.

Table 1. Literature Review Green Higway

Literature	Result
Najwa, 2015	Contains a review of some definitions of green highway and some terms in it to increase knowledge and awareness of the concept of green highway. In this study also discussed about the 8 green rating system. Green highway criteria based on this research are road drainage management, renewable energy and emission reduction, recycle, reuse and renewable, ecosystem conservation and management, social added value of the community.[7]
Balubaid, 2015	Explained some of guidelines and tools for assessing the application of green highway in Malaysia based on several criteria. The criteria used are based on a literature review of the green highway rating system. The criteria obtained are sustainable design and construction activities, energy efficiency, environmental and water management, material technology, social and safety.[8]
Eisenman, 2012	Describes the comparison of the green highway rating system to be the basis of the green highway assessment framework at the Georgia Department of Transportation. From several rating systems, GreenLITES system was chosen as the basic framework and then adjusted to the conditions of the Georgian region. The category of green highway rating system resulting from this study are sustainable sites, water quality and quantity, material and material resources, energy and atmosphere, innovation.[9]
Talati, 2013	Explains that a road can be categorized as a green highway starting from the planning, construction and maintenance phases. As for each phase there are categories namely road water drainage management, recycle, reuse and renewable materials, ecosystem management and conservation, life-cycle energy on the road.[2]
Lee, 2013	The process of evaluating green highway criteria by using comparison of assessment and assessment methods uses life-cycle cost analysis and life-cycle assessment. The rating system used is BE2ST with the criteria considered energy consumption, greenhouse gas emissions, water consumption, handling of hazardous waste.[10]

Based on the results of interviews with experts, obtained 6 main aspects of the application of the green highway concept. six aspects include water management and drainage, green materials, sustainable sites, energy emissions and waste reduction, social and economic, life-cycle analysis. The 6 aspects translated into 20 indicators obtained from the green rating system which can be seen in table 2. These 20 indicators will be the research variables to be measured.

Table 2. Application of the Green Highway Concept on Investment in Toll Road Development in Indonesia

Aspect	Variable	Indicator	Literature
Water Management and Drainage	X1	Reduction of pollutant levels in water sources.	INVEST, GreenLITES, Green City, I-LAST
	X2	Road slope and side cliff design with high water permeability.	GreenLITES, Green roads
	X3	The use of pavement material with high water permeability.	I-LAST, GreenLITES.
Green Materials	X4	The use of non-hazardous recycled materials.	GreenLITES, I-LAST, Envision, Green Roads, BE2ST, INVEST.
	X5	The use of environmentally friendly materials.	I-LAST, Green roads.
Sustainable Sites	X6	Design and selection of environmental alignment of road alignments.	INVEST, I-LAST, Green Roads, GreenLITES.
	X7	Land use plan integrated with road development areas.	INVEST, Green Roads, GreenLITES, I-LAST, Green City.
	X8	Protection, enhancement and restoration of wildlife habitat in the area of road development.	BE2ST, INVEST, Green Roads, GreenLITES, I-LAST, Envision, Green City.
	X9	Protection, replanting trees, and mitigating the cutting of trees in the area of road development.	BE2ST, INVEST, Green Roads, GreenLITES, I-LAST, Envision, Green City.
	X10	Green road landscape management.	BE2ST, INVEST, Green Roads, GreenLITES, I-LAST, Green City.
Energy, Emission and Waste Reduction	X11	Reducing fuel consumption by using environmentally friendly equipment.	BE2ST, INVEST, Green Roads, GreenLITES, I-LAST, Envision, Green City.
	X12	Reducing the use of electricity by using renewable energy.	BE2ST, INVEST, Green Roads, GreenLITES, I-LAST, Envision, Green City.
	X13	Improve road performance and services.	INVEST, Green Roads, GreenLITES, I-LAST,.
	X14	Noise reduction during construction and operation.	BE2ST, INVEST, Green Roads, GreenLITES, I-LAST, Envision.
	X15	Waste material management.	BE2ST, INVEST, Green Roads, Green City.
Social and Economy	X16	Business development and employment around the road.	INVEST, Green Roads, Envision.
	X17	The location of local material sources around the road.	Green Roads, GreenLITES, I-LAST.
Life Cycle Cost Analysis	X18	Life cycle costs analysis of using alternative designs and environmentally friendly pavement materials.	BE2ST, INVEST.
	X19	Life cycle costs analysis of using alternative water management and drainage designs that are environmentally friendly.	BE2ST, INVEST.
	X20	Life cycle cost analysis of the use of alternative, environmentally friendly road building structures.	BE2ST, INVEST.

3. RESULTS AND DISCUSSION

3.1. Result of Quantitative Analysis

The response in this research was representatives from toll road business entities in Java, Sumatera, Kalimantan and Sulawesi with positions manager, board of director (BOD), and 1 level below the BOD (BOD-1) with total 82 respondents. Profile of respondents can be seen in Figure 1.

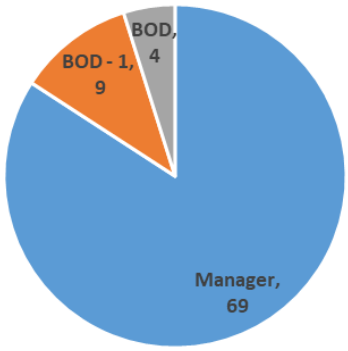

Figure 1. Profile of Respondents by Position

The results of the questionnaire survey in the form of respondents' answers regarding the application of the green highway concept in investment in toll road development in Indonesia are interpreted with descriptive analysis can be seen in table 3. The purpose of the analysis descriptive is to describe or indicate ranking factors starting from the important to the unimportant based on the perception of respondents, based on the average value of perception respondents on each factor and the value of the standard deviation [11].

Table 3. Descriptive Analysis

No	Variable	Minimum	Maximum	Mean	SD
1	X1	1	5	3.8293	1.016
2	X2	1	5	4.0244	0.955
3	X3	1	5	3.5732	1.133
4	X4	1	5	3.8049	0.961
5	X5	2	5	4.1220	0.908
6	X6	1	5	4.1585	0.962
7	X7	2	5	4.3171	0.799
8	X8	1	5	3.8171	1.090
9	X9	2	5	3.9756	0.994
10	X10	2	5	4.1098	0.875
11	X11	2	5	3.5366	1.045
12	X12	1	5	3.6220	1.073
13	X13	3	5	4.4146	0.647
14	X14	2	5	3.9268	0.798
15	X15	2	5	4.1098	0.832
16	X16	3	5	4.2561	0.717
17	X17	2	5	4.0244	0.875
18	X18	1	5	3.9268	0.899
19	X19	2	5	3.8659	1.015
20	X20	2	5	3.9512	0.942

The results of the comparison between mean and SD are then interpreted using a Cartesian diagram to see the position of the variables in the quadrant. It can be seen by groups of variable based on their quadrant position. Quadrant division used the average value of the mean and the average value of standard deviation. Cartesian diagram is presented in Figure 2 Can be explained that the quadrant sequence has the most priority to the weakest variable started from quadrant I, quadrant II, quadrant III, then quadrant IV [12].

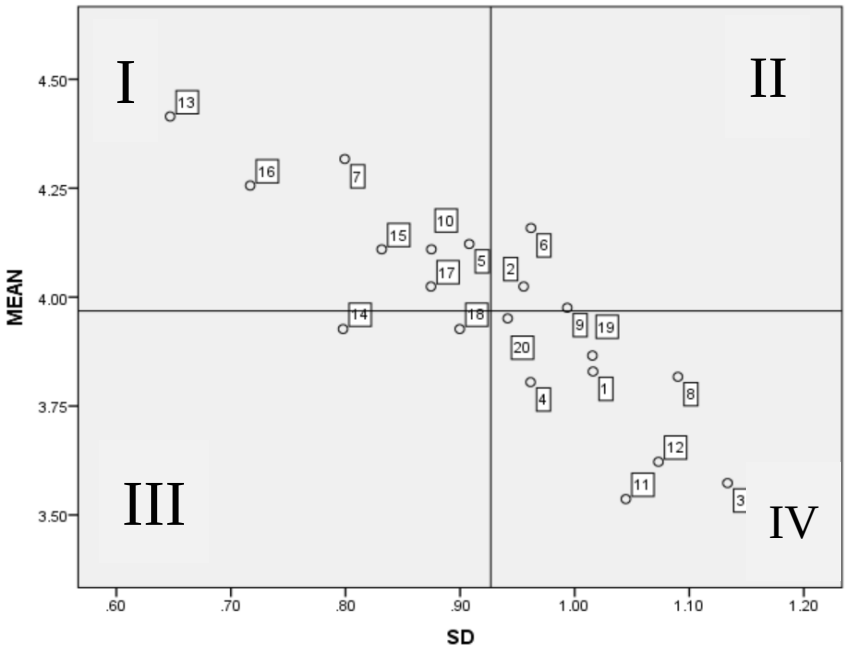

Figure 2. Diagram Mean-SD

Based on the results of the mean-sd diagram, priority variables can be grouped into:

1. Quadrant I : X13, X7, X16, X15, X10, X5 and X17.
2. Quadrant II : X6, X2 and X9.
3. Quadrant III : X14 and X18.
4. Quadrant IV : X20, X19, X1, X4, X8, X12, X11 and X3.

4. CONCLUSION

Based on the analysis, it can be seen that the factors for implementing the green highway concept to the development of toll roads in Indonesia based on priority levels can be grouped as follows:

1. Priority I
   Improve road performance and services, land use plan integrated with road development areas, business development and employment around the road, waste material management, Green road landscape management, the use of environmentally friendly materials, the location of local material sources around the road.
2. Priority II
   Design and selection of environmental alignment of road alignments, road slope and side cliff design with high water permeability and protection, replanting trees, and mitigating the cutting of trees in the area of road development.
3. Priority III
   Noise reduction during construction and operation, life cycle costs analysis of using alternative designs and environmentally friendly pavement materials
4. Priority IV
   Life cycle cost analysis of the use of alternative, environmentally friendly road building structures, life cycle costs analysis of using alternative water management and drainage designs that are environmentally friendly, reduction of pollutant levels in water sources, the use of non-hazardous recycled materials, protection, enhancement and restoration of wildlife habitat in the area of road development, reducing the use of electricity by using renewable energy, reducing fuel consumption by using environmentally friendly equipment and the

use of pavement material with high water permeability.

The most priority factor for implementing the green highway concept to the development of toll roads in Indonesia is improve road performances and services.

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