Semesta Teknika
Vol . 27, No. 2, 118 - 126, November 2024
DOI: https://doi.org/10.18196/st.v27i2.21917

Analysis of Stakeholder's Understanding of Green Roads Principles in Construction of Yogyakarta-Bawen Toll Road Section I

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Keywords:
stakeholder understanding; green roads; toll road

Abstract
Infrastructure plays a vital role in economic development. Apart from having a positive impact, infrastructure development also has negative impacts such as global warming and reduced availability of natural resources. Therefore, a sustainable approach must be applied in construction projects, especially road construction. Considering the lack of awareness regarding implementing sustainable construction, this research aims to analyze the level and differences in stakeholder understanding regarding green roads in the Jogja – Bawen Toll Road construction project (section 1). This research uses a quantitative approach which uses primary data as the main data. Primary data was obtained through filling out questionnaires by respondents consisting of owners, consultants and contractors involved in the Yogyakarta-Bawen Toll Road Project (section 1). Based on data analysis, it can be concluded that the owner and contractor understand all the principles of sustainable construction, while the consultant only understands social and environmental principles.

INTRODUCTION

The modern era makes all development and growth increase rapidly. This development and growth are what drive demand to increase in various factors, especially in the economic sector. To meet needs, infrastructure fully encourages the development and growth of global competitiveness and the national economy. Infrastructure plays a significantly important role in the economy. One of these infrastructures is road infrastructure.

Road infrastructure acts as a strategic way to help increase economic competitiveness between regions. Apart from that, it also provides connectivity for all activities between regions. Therefore, Indonesian government is planning 1000 km toll road program included in the National Medium Term Development Plan (RPJMN), one of which is the construction of the Jogja-Bawen Toll Road. The Jogja-Bawen Toll Road is a national strategy project connecting the southern and northern parts which was built to implement the government program.

In the past, most road projects were only aimed at increasing economic growth and creating jobs. Therefore, throughout planning, design, construction, maintenance and repair, the impact on the environment from aspects such as route selection, road type, construction methods and material selection are generally ignored (Huang & Yeh, 2008). The construction process not only produces large amounts of waste and pollution, but also consumes large amounts of natural resources. Therefore, a sustainable approach is needed to be applied in construction projects, especially road construction, starting from the design, construction and renovation stages (Park & Ahn, 2015).

The building construction sector has previously developed green rating systems, for example LEED, Green Globes and BREEAM to assist stakeholders in the construction sector in identifying and implementing green practices (Pearce et al., 2012). Even though green rating systems in building construction have been popular for the last ± 20 years, sustainability issues have not been seriously adopted in infrastructure projects, especially road infrastructure. The concept of sustainability is very important for road construction, because

environmentally friendly practices can improve economic prosperity and quality of life and at the same time can protect the environment (Pearce et al., 2012).

Green roads are road construction projects that are planned and developed to a level of sustainability that is much higher than existing standard practices (Singh et al., 2012) and use green and low-pollutant materials during the construction process (Reddy, 2011). The benefits of implementing the green roads concept include benefits for the environment (ecocentric) and benefits for humans (anthropocentric). Benefits for the environment include reducing the use of materials, fossil fuels, water, air pollution, greenhouse gas emissions, water pollution, solid waste and being able to restore/form habitat. Benefits for humans include improving access, mobility, health and safety, local economy, aesthetics and reducing life cycle costs (Ervianto, 2013).

Research related to green roads and sustainable roads in Indonesia began with research (Lawalata, 2013). This research aims to find out the principles of sustainable roads from around the world, such as Greenroads, INVEST, and I-LAST. The next research is research (Ervianto, 2013) which aims to obtain information about environmentally friendly new road construction process activities in the aspect of natural resource conservation. From this research it was found that the hot mixing process produces relatively large CO2 emissions, therefore this method needs to be replaced with a more environmentally friendly mixing process. Apart from that, implementing the in-place recycling method can increase work effectiveness and encourage energy savings in transportation activities.

Research on readiness and obstacles in implementing green roads construction was conducted by (Mustofa et al., 2017). The research results show that the government's level of readiness is ready, contractors: quite ready and consultants: quite ready and the main obstacle to implementing green roads is the limited budget. (Lawalata, 2019) conducted research with the aim of reviewing the implementation of green roads ranking and identifying green roads subcategories that are difficult to implement. The green roads rating subcategories that are less widely applied are the subcategories found in the materials and natural resources category and the pavement technology category.

The application of green roads construction in Indonesia is very useful and interesting, this concept should be the most important core part from the planning to maintenance stages in a sustainable construction development. Even though Indonesia itself is still very early in implementing sustainable construction compared to other developed countries, small steps can be taken to get started. Considering the lack of awareness regarding the implementation of sustainable construction, the aim of this research is to analyze the level and differences in stakeholder understanding regarding green roads in Jogja – Bawen Toll Road construction project (section 1).

RESEARCH METHODS

This research uses a quantitative approach which uses primary data as the main data. Primary data was obtained through filling out questionnaires by respondents. The questionnaire consists of two parts, the first part is the respondent data form and the second part of the questionnaire is the weighting of green roads principles which consist of social, economic and environmental principles. These principles can be seen in table 1. Filling out the questionnaire uses a 1-5 Likert scale, an explanation of the weights and linguistic variables on the Likert scale can be seen in table 2.

Table 1. Green Roads Principles

No	Green Roads Principles
	Social Principles
1	Equal access for road users
2	Changes in behavior and increased abilities
3	Protect and develop culture and history
4	Society participation
5	Health, safety and noise protection
6	Road safety audit
	Economy Principles

No	Green Roads Principles
1	Road geometry design
2	Use of pavement technology
3	Maintaining the quality of work
4	Savings on transportation of materials, personnel and water during implementation
5	Energy savings (saving fossil fuels, using diesel/other energy)
6	Material savings (reuse, recycle, local materials)
7	Flood cost analysis
8	The service provider has ISO quality management and environmental management certificates
9	Road pavement cost analysis
	Environmental Principles
1	Environmental and ecosystem protection (animals)
2	Air protection
3	Light settings
4	Water settings
5	Energy settings
6	Construction material reduce
7	Reforesting
8	Arrangement of waterproof surfaces

Source: (Lawalata, 2013)

Table 2. Likert Scale Weights and Linguistic Variables

Weight	Linguistic Variables
1	Strongly disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly agree

The questionnaire was filled in by respondents consisting of owners, consultants and contractors involved in the Yogyakarta-Bawen Toll Road Project (section 1), totaling 30 people. Respondents were selected using purposive and snowball sampling methods. After all respondents have filled out the questionnaire, the results of the questionnaire will be tabulated and then analyzed using the severity index method to obtain the level of understanding of each stakeholder. The category of stakeholder understanding is divided into not understanding, slightly understanding, understanding and very understanding as seen in Figure 1. To analyze differences in understanding between stakeholders, the Kruskall-Wallis method is used if the data is normally distributed and One Way Anova if the data is not normally distributed.

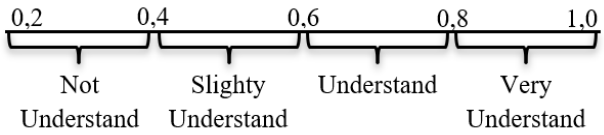

Figure 1. Understanding Category

RESULTS AND DISCUSSION

The research results are divided into several parts, namely analysis of stakeholder understanding of the green roads principles using the severity index method, analysis of differences in stakeholder understanding using the Kruskal-Wallis method and discussion. Each of these parts will be discussed in a separate sub-chapter.

Stakeholder Understanding Analysis

The results of calculating the severity index for the social principles of each stakeholder can be seen in table 3. The severity index value for all social principles is > 0.6, which indicates that all stakeholders understand the social principles of the green roads. The highest severity index value for social principles is road safety audits and equal access for road users.

Table 3. Severity Index Values on Social Principles

No.	Variable	Owner	Consultant	Contractor
1	Equal access for road users	0,83	0,96	0,96
2	Changes in behavior and increased abilities	0,80	0,8	0,88
3	Protect and develop culture and history	0,71	0,76	0,94
4	Society participation	0,69	0,8	0,84
5	Health, safety and noise protection	0,86	0,92	0,88
6	Road safety audit	0,89	0,86	0,90

Source: Data Analysis, 2023

The results of calculating the severity index on the economic principles of each stakeholder can be seen in table 4. The severity index value for the owner and contractor respondents for each economic principle is above 0.6, which indicates that the owner and contractor understand the economic principles on green roads. However, consultant respondents have a severity index value of <0.6, namely the principle of saving energy and saving material. This illustrates that consultants have little understanding of these two principles. The highest severity index value for economic principles is that the service provider has ISO quality management and environmental management and road design (geometric) certificates.

Table 4. Severity Index Values on Economy Principles

No.	Variable	Owner	Consultant	Contractor
1	Road geometry design	0,83	0,98	0,88
2	Use of pavement technology	0,83	0,72	0,80
3	Maintaining the quality of work	0,83	0,84	0,86
4	Savings on transportation of materials, personnel and water during implementation	0,83	0,64	0,78
5	Energy savings (saving fossil fuels, using diesel/other energy)	0,71	0,58	0,60
6	Material savings (reuse, recycle, local materials)	0,71	0,50	0,74
7	Flood cost analysis	0,83	0,80	0,86
8	The service provider has ISO quality management and environmental management certificates	0,86	0,86	0,96
9	Road pavement cost analysis	0,83	0,68	0,88

Source: Data Analysis, 2023

The results of calculating the severity index for the environmental principles of each stakeholder can be seen in table 5. The severity index value for all environmental principles is > 0.6, which indicates that all stakeholders understand the environmental principles of green roads. Environmental principles' highest severity index value is greening, water management and air protection.

Table 5. Severity Index Values on Environment Principles

No.	Variable	Owner	Consultant	Contractor
1	Environmental and ecosystem protection (animals)	0,77	0,70	0,84
2	Air protection	0,80	0,84	0,92
3	Light settings	0,74	0,72	0,82
4	Water settings	0,83	0,86	0,88
5	Energy settings	0,74	0,70	0,76
6	Material reduce	0,71	0,68	0,76
7	Reforesting	0,86	0,82	0,92
8	Arrangement of waterproof surfaces	0,77	0,76	0,82

Source: Data Analysis, 2023

Analysis of Differences in Stakeholder Understanding

To analyze differences in understanding between respondents regarding the principles of green roads, the first step taken was a data normality test. The data normality test was carried out with a significance value (α) of 0.05. The data normality test hypothesis is as follows:

H0 = data is normally distributed

H1 = data is not normally distributed

If the significance value of the normality test is > 0.05 then H0 is accepted. The results of the normality test can be seen in table 6. For social principles, the significance value for consultant respondents is < 0.05 so that the data for consultant respondents is not normally distributed. For economic principles, all data from all respondents is normally distributed and for environmental principles, data from consultant respondents is not normally distributed, as evidenced by a significance value of < 0.05

Table 6. Normality Test Result

Principles	Respondent	Significant Value	Explanation
Social	Owner	0,567	Normally distributed
	Consultant	0,028	Not normally distributed
	Contractor	0,319	Normally distributed
Economy	Owner	0,012	Not normally distributed
	Consultant	0,197	Normally distributed
	Contractor	0,900	Normally distributed
Environment	Owner	0,722	Normally distributed
	Consultant	0,001	Not normally distributed
	Contractor	0,402	Normally distributed

Source: Data Analysis, 2023

After the normality test and the results obtained that the data is not normally distributed, the next step is to test the difference in understanding using the Kruskall-Wallis test with a significance level (α) of 0.05. The hypothesis for testing differences in understanding is as follows:

H0 = There is no difference in understanding between stakeholders

H1 = There is a difference in understanding between stakeholders

If the significance value of the Kruskall-Wallis test is >0.05 then H0 is accepted. The results of the Kruskal-Wallis test can be seen in table 7. Based on table 7, the significance value for social, economic and

environmental principles is > 0.05. This proves that there is no difference in understanding between owners, consultants and contractors regarding the social, economic and environmental principles that exist on green roads.

Table 7. Kruskall-Wallis Test Result

Significant Value	Social Principles	Economy Principles	Environment Principles
	0,052	0,194	0,130

Source: Data Analysis, 2023

Discussion

In terms of social principles, the highest severity index value for owner respondents is the road safety audit principle. According to (Nishimura, 2017), a road safety audit is a formal road safety inspection of a road or traffic project, or other type of safety project that affects road users, carried out by an independent auditor or team of auditors, qualified to report on the project's accident potential and safety performance for all types of road users. Road safety audits are part of a traffic accident prevention strategy (Gitelman & Doveh, 2016). Apart from causing death, trauma and minor injuries, traffic accidents also cause damage to property and infrastructure, the number of which is increasing every year. Losses due to traffic accidents in 2014 were estimated at 250 billion rupiah (Jusuf et al., 2017). Therefore, road safety audits are a very important aspect of the social principles of the green roads concept.

The highest severity index value for consultant and contractor respondents in social principles is equal access for road users. Equality access for road users is related to gender-based infrastructure, namely infrastructure that can be utilized by women, men and other groups with special needs (elderly, disabled, children) according to their needs to be able to carry out activities independently. Infrastructure must also be able to provide security, safety and user comfort, such as street lighting, safe building design, obstacle-free sidewalk design, and minimize the potential for flooding, because it is designed to be environmentally friendly (Astuti & Pane, 2022).

In terms of economic principles, the highest severity index values for owner and contractor respondents are ISO implementation for quality management and environmental management. Implementing a quality management system is a strategic decision for an organization that can help the organization to improve its overall performance and provide a strong foundation for sustainable development initiatives (Wartuny et al., 2018). For owners, emphasis on quality is very necessary because one of the success factors in road construction projects is the implementation of an effective quality assurance program (Zachawerus & Soekiman, 2018). Improving the quality of construction projects is associated with quality management in the project life cycle. Although quality management at each stage of the project life cycle is important, quality management at the implementation (construction) stage makes a significant contribution to the final quality results of a construction project (Ashokkumar, 2007), therefore contractors have a large role in determining the quality of a construction project.

The highest severity index value for consultant respondents in economy principles is road design (geometric). Consultants are expected to be able to design road geometrics that can guarantee the safety and comfort of road users and can reduce energy use, for example longitudinal slopes are designed not to be steep, slopes are provided for exiting sidewalks such as crossings and intersections. Apart from that, the road geometry is also designed to support the conservation/habitat areas it passes through. For example, on Pekanbaru – Dumai Toll Road Section 4, 5 crossing structures are accommodated in the form of bridges with a span of 25 – 45 m and a clear height of 5.1 m. This structure is called an elephant underpass which is equipped with landscaping in the form of green plants which can attract elephants to cross it (Astuti & Pane, 2022).

In terms of economic principles with consultant respondents, there is a severity index value of <0.6, namely on the principles of energy management and material savings, which indicates that consultants do not understand the principles of energy saving and material saving in green roads construction. This is in line with research by (Santosa & Lawalata, 2019) who examined the categories and subcategories of green roads that are least applied, namely the Materials and Natural Resources Category, which includes the reuse of dismantled materials, such as road pavement or other materials, the use of local materials, and use of renewable natural resources. Implementation of this subcategory generally requires large funds as capital. To implement subcategories in this category, supporting technology is needed, so that procurement costs and implementation costs can be minimized.

An example of dismantling material that can be used in road construction projects is the dismantling of road asphalt as a road foundation layer material. The research results of (Widodo et al., 2013) show that the addition of cement of 0.5% and 2.5% can improve the CBR value by 36% and 94% respectively so that it can be used as a material for the lower and upper foundations of highways. Apart from dismantling asphalt, another dismantling material that can be used is dismantling concrete roads. Based on (Angka et al., 2022), the characteristics of the concrete road demolition material fragments meet the coarse aggregate specifications, so they are suitable for use in AC-WC mixtures.

Energy management can be done by implementing the in-situ recycling method (recycling at the work location) so it can increase work effectiveness and encourage energy savings in transportation activities and be able to reduce pollution or greenhouse gas emissions (Ervianto, 2013). Apart from that, energy management can be done by using energy efficient public street lighting lamps. The government cooperation policy with business entities on energy conservation for energy efficiency and public street lighting lamps has been implemented by regional governments and has been proven to be able to reduce the burden on regional governments in financing management, especially the efficiency costs/budgets in the APBD (Pranasari & Ferza, 2018).

In terms of environmental principles, the highest severity index value for owner and contractor respondents is reforesting principle. The carbon emissions produced in road construction are 1,200 tons of CO2, which is equivalent to the emissions of 210 passenger cars in one year (Greenroad Foundation, 2010), therefore reforesting principles are very important to apply in sustainable road construction projects. Reforesting can be done by protecting critical land (water, soil, animals) using plants that have special functions, providing water absorption space at the base of trees on the sidewalk, replacing trees that have to be cut down due to construction and avoiding damage to trees and plants during the implementation phase construction at the job site.

The highest severity index value for consultant respondents in environment principles is water management. The water management in question is the provision of a road drainage system. The road drainage system is designed with a sustainable pattern considering water quality, location convenience and the potential for increasing habitat in the environment. This sustainable road drainage system can be developed in Indonesia while still paying attention to the different regional conditions and topography in each region with the concept of local wisdom in each region (Yunianta et al., 2022).

CONCLUSION

Based on the severity index analysis, the owner's and contractor's understanding of the social, economic and environmental principles of green roads is at an understanding level. However, there are differences between consultants where consultants only understand social and environmental principles, but do not yet understand the economic principles of green roads. Based on the Kruskal-Wallis test, in general there is no difference in the understanding of owners, consultants and contractors regarding the principles of green roads. Further research can analyze the implementation of green roads and the obstacles in the Yogyakarta-Bawen Toll Road Project (Section I).

ACKNOWLEDGEMENT

The researchers acknowledge Universitas Muhammadiyah Purworejo, who provided funding for this research.

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