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Evaluation of Street Lighting Levels on Road User Safety and Security : Case Study Cikijing - Majalengka

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ABSTRACT

Road infrastructure is an important foundation for economic growth and the movement of people around the world. Road lighting also plays a vital role in safe driving at night. Roads are local infrastructure that facilitate trade, tourism and cross-border interaction. Traffic acts as a means of land transportation that makes it easier for individuals to travel and companies to distribute their products to various regions. Therefore, creating a safe and comfortable environment for the community involves various aspects, one of which is lighting. In the context of driving safety, the case that occurs on the Cikijing - Majalengka road is the absence of adequate road lighting, endangering road users at night. Adequate lighting plays an important role in preventing crime, because criminals tend to avoid areas that are well lit and easily monitored. The location of this research was carried out on the Cikijing - Majalengka highway, more precisely on the Cikebo Block highway, Maja District. This research uses qualitative methods to analyze perceptions. because this method is more suitable for answering research questions that cannot be answered quantitatively. This study measured respondents' perceptions of street lighting based on two parameters: level of importance and level of satisfaction. Measurements were made using a Likert scale of 1 to 5 with a range from "not important" to "very important" for importance, and from "not satisfied" to "very satisfied" for satisfaction. The data collected was then analyzed using the (IPA) method. Based on data collected from 50 respondents, the Cikijing-Majalengka road user profile is dominated by men, with the majority aged ≤ 20 years, and the most commonly used vehicle is a motorcycle. Users over 60 years of age are relatively rare on this road section.

1. Introducation

Infrastructure roads are an important foundation for economic growth and the movement of people globally [1]. Street lighting also plays a vital role in safe driving at night. Good street lighting not only lowers the risk of traffic accidents, but also creates a safer environment by reducing opportunities for crime. The use of street lighting as a means of crime prevention has been widely recognized, making it an equitable investment in many environmental designs [2]. Therefore, modern urban planning always considers street lighting as an integral part of the infrastructure. Furthermore, the presence of adequate street lights also contributes to increased economic activity at night, as people feel safer to go outdoors. The presence of special street lighting to improve the safety of road users, including drivers and pedestrians, while minimizing crime [3].

Roads are local infrastructure that facilitate trade, tourism and cross-border interactions [4]. With the development of the times, time constraints have been eliminated. Many people now utilize both day and night to maximize efficiency and success. The provision of street lighting is the responsibility of local governments to fulfill the rights of all road users. Of course, with proper and standard installation, as well as quality lighting, street lighting can provide maximum benefits for road users. In an effort to create safer environments, many cities are investing in street lighting programs as a means of crime prevention [5]. Therefore, investment in street lighting is a strategic move that has a positive impact on various aspects of people's lives, ranging from security, economy, to general quality of life.

Traffic participate as a means of land transportation that allows individuals to travel and companies to distribute their products to various regions [6]. Therefore, creating a safe and comfortable environment for the community involves various aspects, one of which is lighting. Adequate lighting plays an important role in preventing crime, because criminals tend to avoid areas that are well-lit and easily monitored [7]. The absence of street lighting not only increases the risk of traffic accidents, but also limits economic activity at night, which ultimately costs the community. As such, the provision of adequate street lighting is a critical investment in safety and the local economy. Therefore, local governments need to prioritize budget allocation and careful planning to ensure effective and sustainable availability and maintenance of street lighting infrastructure.

In the context of driving safety, the case that occurs on the Cikijing - Majalengka road is the absence of adequate road lighting, endangering road users at night. Adequate lighting plays an important role in preventing crime, because criminals tend to avoid areas that are well lit and easily monitored. Optimal lighting can provide a sense of security and reduce concerns about crime [8]. As such, street lighting is not just a lighting facility, but also a strategic investment that impacts the safety, security, economy, and overall quality of life of the community. Therefore, local governments need to prioritize the provision and maintenance of adequate street lighting throughout the region. This study highlights minimal lighting on the Cikijing-Majalengka road and its impact on road users.

2. Literature Review

2.1 Traffic

Motorized vehicle traffic plays an important role in the emergence of urban problems, especially those related to safety (accidents) and environmental quality (pollution) [9]. It can be concluded that traffic consists of several elements, namely people, vehicles, and roads. These three elements play a crucial role in creating a harmonious traffic system. Globalization was driven by advances in communications and road transportation, which resulted in increased spatial accessibility, facilitated the movement of people and goods across countries, and encouraged global trade and cultural exchange [10]. Achieving a sustainable traffic system requires continuous innovation in transportation technology and traffic management, including the development of efficient and environmentally friendly public transportation systems. In addition, education and effective law enforcement are also important to increase road user awareness and compliance.

Interactions in the traffic system involve three important elements, road users (humans), vehicles, and road infrastructure [11]. Road sections are land transportation facilities that include the entire physical construction of the road, supporting structures, and equipment, which play an important role in traffic mobilit [12]. Related aspects include vehicles, pedestrians, traffic control devices, and binding regulations. The challenges of handling congestion in urban areas are increasingly complex and difficult to overcome. Given that transportation volumes are predicted to continue to increase, more action is needed than just continuous monitoring [13]. Long-term solutions require an integrated approach, involving the development of modern and environmentally friendly public transportation infrastructure, as well as the implementation of smart, technology-based traffic management systems.

Integration between transportation modes is also important to provide more efficient mobility alternatives for the public.

Traffic is a set of rules, facilities and infrastructure designed to ensure safety, security, order and smooth flow of traffic on the road [14]. Traffic is the set of rules, regulations, devices, and infrastructure that governs roads The efficiency of traffic systems can be improved through the implementation of various techniques managed. Traffic management aims to improve effectiveness of traffic flow by reducing disruption and congestion. Ultimately, effective traffic management creates a better transportation environment, supporting economic growth and quality of life. The complexity of modern networks, caused by rapid technological advances, affects the flow of network traffic [15]. In addition, integration between different modes of transportation, such as public transportation, private vehicles, and bicycles, is also important to create an efficient and sustainable transportation system amidst the complexity of modern networks.

2.2 Road User Safety

Traffic safety is a major concern in today's society, given the high number of accidents that have a significant impact on human and material losses on a global scale [16]. High-income countries generally record stagnant or even declining traffic accident fatality rates, in contrast to low- and middle-income countries which are facing an increasing trend [17]. Therefore, efforts to improve traffic safety in low- and middle-income countries need to focus on improving the quality of road infrastructure, stricter law enforcement, and effective education and outreach programs to the public.Investment in Driving safety, Reducing the number of accidents and the socio-economic impact of traffic accidents is crucial, especially in a low- and middle-income country. . The impact of traffic accidents is very significant, harming individuals, society and the economy [18].

Safety in traffic systems is largely determined by how road users behave. Intelligent transportation has proven effective in vehicle management, improving traffic performance, increasing travel safety, and expanding choices for travelers [19]. The synergy between compliant road users and intelligent transportation systems creates an optimal traffic environment, where technology supports responsible behavior. As such, investments in intelligent transportation infrastructure must be matched by efforts to improve road user awareness and discipline. Reducing speed limits on certain roads, coupled with effective enforcement, is widely recognized as one of the most effective ways to reduce road fatalities [20].

Road condition is a crucial factor in traffic safety. The risk of accidents can increase with poor road conditions. Frequent traffic accidents are a serious threat to public safety on the highway [21]. Routine and planned repair and maintenance of road infrastructure is important to minimize the potential for road-related accidents. In addition, increasing road users' awareness and compliance with traffic signs and rules is also crucial to creating a safer traffic environment. The tragedy of traffic accidents not only claims lives, but also causes damage to assets and property [22].

2.3 Road Lighting

Traffic lighting systems comprise interconnected electrical components designed to provide illumination and signaling, including traffic signals, streetlights, and illuminated signage..Adequate street lighting plays a crucial role in reducing the potential for traffic accidents due to limited visibility, although darkness is rarely the sole cause of accidents [23]. Traffic lights that are not working properly or are not functioning properly can trigger various dangerous situations that have the potential to cause accidents [24]. Therefore, maintenance and repair of traffic lighting systems, especially traffic lights, are essential to maintain traffic safety, smoothness and efficiency. Adequate lighting, including traffic lights, improves visibility at night, reducing the risk of accidents and crime. Sreet lighting in the traffic system

aims to create a safe and comfortable place for all road users, including drivers and pedestrians, when carrying out activities at night. [25]. A major transformation is taking place in global street lighting technology, marked by a change in the types of lamps used [26]. The changeover was driven by the desire to Optimize energy use and reduce environmental footprint, as well as improve lighting quality for better visibility. In addition, the new technology also offers advanced features such as light intensity control and connectivity, enabling more efficient management and maintenance.

The main function of street lights is to increase visibility at night, so drivers can see potential hazards more easily and drive safely, which ultimately reduces the number of accidents [27]. Adequate lighting also provides a sense of security for pedestrians and cyclists. Thus, street lights play a role in creating a safer and more comfortable traffic environment for all. The increase in serious crimes at night, such as robbery, assault, and battery, has caused widespread anxiety and fear among pedestrians [28]. Traffic management aims to improve the efficiency of traffic flow by reducing disruption and congestion. Ultimately, effective traffic management creates a better transportation environment, supports economic growth, and improves people's quality of life.

3. Method

Research is generally defined as a systematic effort undertaken by competent individuals to gain more comprehensive understanding or knowledge. This study uses qualitative methods to analyze perceptions because these methods are more suitable for answering research questions that have not yet been quantitatively explained. This article aims to describe how semi-structured interviews as a research instrument are used in qualitative research [29]. This research data presents road users' perceptions of the importance of lighting for their safety and security on the road.

This study evaluates the lack of lighting on the Cikijing - Majalengka road using road user perceptions as the main variable. Primary data was obtained through a questionnaire filled out by 50 respondents who are Cikijing - Majalengka road users. This study measures respondents' perceptions of street lighting based on two parameters: level of importance and level of satisfaction. Measurements were made using a Likert scale of 1 to 5 with a range from not important to very important for the level of importance, and from dissatisfied to very satisfied for the level of satisfaction. The collected data was then analyzed using the (IPA) method. In an effort to understand customer satisfaction and develop strategies to improve product or service quality, Regarding the location of the research, important-performance analysis (IPA) is usually used as a research technique [30].

Importance Performance Analysis (IPA) usually uses the 4 quadrant method

a. Quadrant 1:This quadrant contains aspects of street lighting that are considered very important by the community and have been well met by the government or service providers. This is an area where performance is optimal and needs to be maintained to maintain community satisfaction and excellence in public service.
b. Quadrant 2:This quadrant contains aspects of street lighting that are actually less important to the community, but the government/service provider has provided high performance. Resources allocated to these aspects should be diverted to other quadrants that are more in need of improvement.
c. Quadrant 3:This quadrant contains aspects of street lighting that are considered less important by the community and have low performance. These aspects do not require high priority for improvement, unless there is a significant change in community needs or available budget
d. Quadrant 4:Contains attributes that are perceived to be very important to customers but performance levels are fairly low.This quadrant contains aspects of street lighting that are considered very important by the community, but their performance is still low. This is the most

urgent area to improve Regarding the research location because it has a direct relationship impact on the safety and comfort of the community [31].

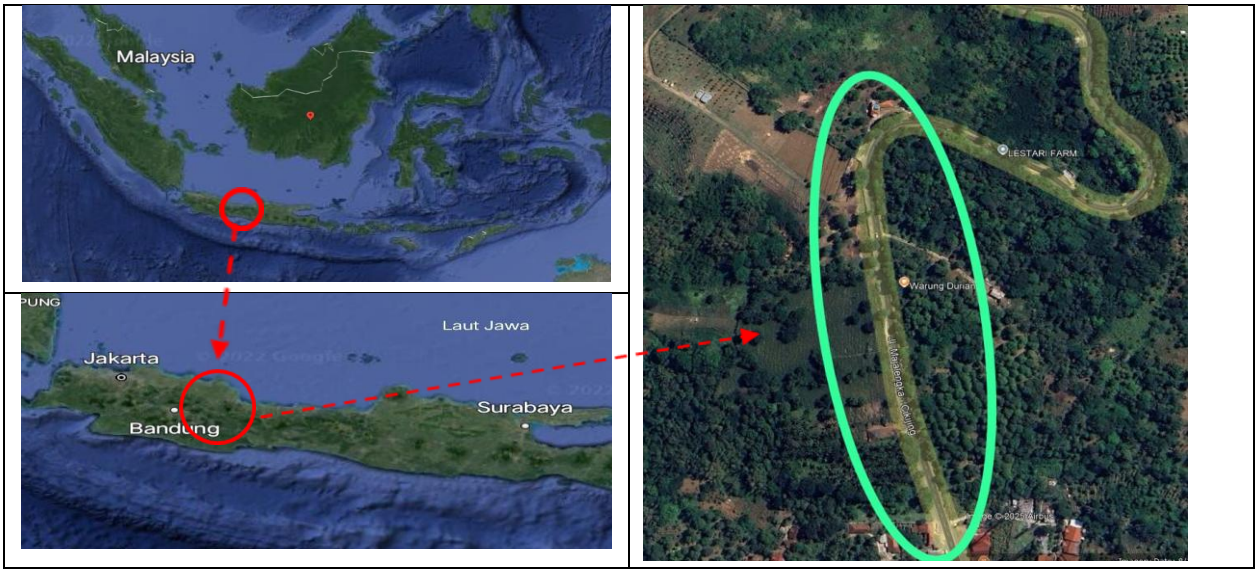

Figure 1: Research Site

4. Results and Discussion

a. Respondent's Personal Information

Based on data collected from 50 respondents, the Cikijing-Majalengka road user profile is dominated by men, with the majority aged ≤ 20 years, and the most commonly used vehicle is a motorcycle. Users over 60 years of age are relatively rare on this road section.

Table 1: Respondent Information

Variable	Category	Frequency	Present
Gender	Male	25	50%
	Famale	25	50%
Age	<20	17	33%
	21-30	24	47%
	31-40	4	8%
	41-50	4	8%
	51-60	1	2%
	>60	1	2%
Vehicles Used	Car	9	18%
	Motorcycle	41	82%

b. The Importance and Performance Level of Road Lighting

Based on the survey results, the lighting variable for safety from crime/accidents (4.38) received the most significant score, but also received the most unsatisfactory score (2.56). In addition, lighting activities other than traffic received the lowest score, namely 4.68.

Tabel 2 : Relevance and performance level of street lights

NO	Indicator	I	P	G
A1	Information for safety from crime	4.38	2.56	-1.82
A2	Lighting for driving safety	4.78	2.57	-2.21
A3	Lighting for driving comfort	4.78	2.00	-2.78
A4	Lighting for visibility	4.72	2.00	-2.72
A5	Lighting for vehicles from the same direction	4.72	2.06	-2.66
A6	Lighting for vehicles from the opposite direction	4.7	2.10	-2.60
A7	Lighting for activities other than those related to traffic	4.68	2.22	-2.46
A8	Lighting for roads on bends	4.72	3.04	-1.68
A9	Lighting for the road to the bridge	4.74	2.94	-1.80
A10	Lighting to avoid road damage	4.06	1.72	-2.34

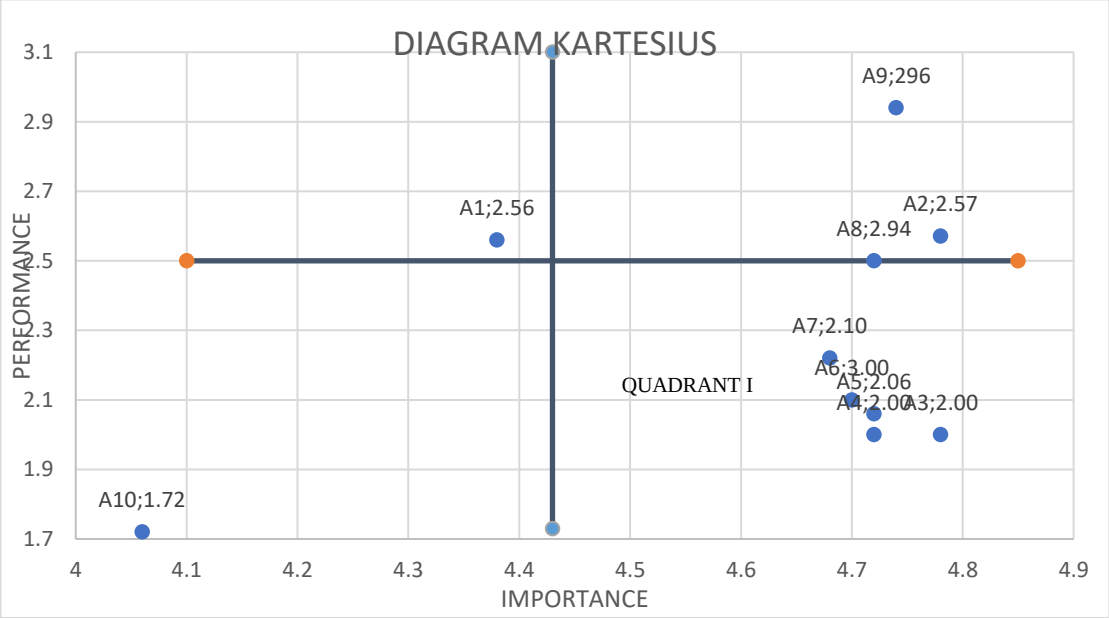

Figure 2 : Relevance and performance level of street lights

The results of the analysis revealed a gap between the level of importance and performance of the lighting, indicated by a negative gap value. The grouping of variables based on the IPA Cartesian diagram resulted in four quadrants: Quadrant IV represents variables with low priority but satisfactory performance; Quadrant III shows variables with equally low priority and performance; Quadrant II contains variables that are important and perform well, so they need to be maintained; and Quadrant I identifies variables that are considered very important but their performance is inadequate, so they require urgent attention and improvement.

After collecting information on road users' perceptions of various aspects of lighting on the Cikijing-Majalengka section, a survey was conducted involving 50 respondents. This survey aims to measure the level of respondents' agreement on the need to improve street lighting. Respondents were given five answer choices on a Likert scale, ranging from disagree, less agree, neutral, agree, to strongly agree. The data obtained from this survey is considered crucial to measure the level of comfort of road users and provide a strong foundation in turning on lighting standards on the road section.

5. Conclusion

The results show a stark difference between the perceived importance and reality of street lighting performance. The average level of importance of lighting was recorded at 4.36, while the level of performance was only 2.27, resulting in a difference or gap of -2.36. This negative number indicates that lighting performance has not met road users' expectations and requires improvement. Given that the majority of Cikijing-Majalengka road users are motorcyclists who are more at risk of becoming victims of crime, the security aspect is a major concern. Lighting as an effort to prevent crime is considered the most important parameter, but ironically, this parameter also received the lowest level of satisfaction. On the other hand, lighting for activities outside the context of traffic is considered less crucial, while the highest satisfaction is felt for lighting that serves to prevent road damage.

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