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Impact of inter-urban street lighting on users perception of road safety behavior: A Case of Jalan Majalengka-Rajagaluh

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Abstract

Road lighting is one of the main things needed by road users to improve safety when driving at night. However, frequently road lights that meet the standards are only on large-scale roads. On the other hand, in general, road users in Majalengka tend to use high speeds. Based on this, this study aims to analyze the impact of lighting on the safety of road users in Jalan Majalengka-Rajagaluh. The research method used in this study is a perceptual analysis method. The results show an average value of road lighting importance is 9.47, the average satisfaction is 6.12, and the average gap is -3.35. Many variables are in quadrant IV, which indicates that many variables still require more concentration to increase. Therefore, according to road users' perception, road lighting is considered essential in various aspects, but road users still feel it is necessary to improve road lighting performance.

Keywords: Road lighting, Road user safety, Road safety

1. Introduction

Road lighting is crucial for drivers to see better at night or in low light. Good road lighting can lower the likelihood of traffic accidents caused by failing to recognize danger when lighting is scarce, even though darkness is not often the primary cause of accidents. Additionally, a variety of road users worldwide may experience traffic accidents. Road traffic accident injuries are a massive problem for international public health issues (Marchant, Hale, & Sadler, 2020). Traffic accidents are the leading cause of death due to injury globally and are expected to be among the top five causes of death by 2030.

In Indonesia, road lighting is regulated by standards. If the lighting is not suitable, either too high and will cause excessive energy consumption and wastage of light, or the light produced is insufficient, so it will not be sufficiently beneficial for pedestrians (Fotios & Gibbons, 2018). So that lighting for road lighting must be suitable and valuable it should. Standards for public road lighting in Indonesia have been included in the Indonesian National Standard (SNI) 7391:2008. Therefore, there should be no more misery over the adjustment of road lighting standards in Indonesia for the safety of road users.

Even though road lighting significantly impacts road users' safety, in West Java, Indonesia, many lighting lamps still need to be monitored for SNI compliance. Most of the causes of accidents are rescuing other vehicles, then losing control of the transportation, then the prohibition of exploding, dim lighting, and several accidents for no definite reason and brake failure (Muhammad et al., 2017). Dim tension is one of the contributing factors to accidents, but the road lights that meet the standard are only on the major road. Both on significant and minor roads, road users still need lighting to provide security so that things like accidents, robberies, and murders that are more likely to occur on roads with minimal lighting can be prevented.

So do in Majalengka Regency; proper lighting is only around main roads, while small roads have



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less lighting. However, accidents that occur at night are more dangerous and severe, so deaths from accidents at night are 8.35% higher than during the day (Ashraf, Hur, Shafiq, & Park, 2019). Therefore, lighting certainly plays a role in the safety of road users. However, on the other hand, road users in Majalengka generally use high speeds on roads that they consider quiet. For this reason, it would be better if adequate road lighting existed evenly on the main and side roads.

Jalan Majalengka-Rajagaluh is one example of a road whose lighting seems neglected even though it is prone to high-speed vehicles. As the options to get to Cirebon, the distance between the lights on the road usually traversed are far from each other and partially blocked by tree branches, especially with dim light bulbs and even some of the light bulbs not working, making the existing lights useless. As a result, driving at night increases the likelihood of an accident more than any other factor (Mphela, 2020). The result of the journal means that the risk of an accident increases at night. However, because Jalan Majalengka-Rajagaluh connects the two regencies, the road tends to remain busy with passing vehicles even at night. However, even though the road has an outer structure and is quite vulnerable, poor road lighting still causes risks to road users. Based on this, the researcher is interested in writing a journal entitled Analysis of Road Lighting Impact on Road User Safety: Case Study of Jalan Majalengka-Rajagaluh.

2. Literature Review

2.1 Road Lighting

Research conducted by Antonio Peña-García and Thi Phuoc Lai Nguyen in their journal entitled A Global Perspective for Sustainable Highway Tunnel Lighting Regulations: Greater Road Safety with a Lower Environmental Impact, stated that among all human activities that have an impact on sustainability and the environment, lighting played a massive role in recent years (Peña-García & Nguyen, 2018). In other words, from the study's results, lighting has played a significant role in the past few years, where light plays a role in increasing the vision of road users in the dark, especially at night. Because when it is dark, awareness of the dangers on the road will decrease, thereby increasing the risk of an accident on the road.

Road lighting has an important role in many aspects for road users, which certainly will require road lighting to fill standards function. However, road lighting is complicated. For example, fading light, lights blocked by shadows, or other obstacles factors that can affect the distribution of light (Yao Q., Wang, Uttley, & Zhuang, 2018). With these possibilities, even though road lighting already has certain standards, fulling road lighting standards can be considered challenging. Even so, the fulfillment of road lighting standards must still be made as much as possible for the safety of road users.

Road lighting has been identified as contributing to reducing traffic accidents (Chenani, Räsänen, & Tetri, 2018). However, there are many ways to reduce the number of traffic accidents, and one of them is road lighting. That way, even though road lighting is not the only one that plays a vital role in reducing the number of traffic accidents at night, improving road lighting can be done to decrease risks.

However, like the road lighting on Jalan Majalengka-Rajagaluh, some lights on the road need to be fixed. Problems such as light scattering, dead light sources, and problems caused by trees can cause different lighting distributions in different sections of the road (Yao Q., Wang, Uttley, & Zhuang, 2018). Because often the lights cannot work optimally because of these problems, the condition of the road lights needs to be controlled regularly so that if a problematic light is found, it can be fixed immediately. So the existing road lighting can function correctly.

When driving at night, the lights from the vehicle are pretty helpful, but road lighting is still needed. We pay attention to the positive effect of road lighting on traffic safety and adjustments for the eye to the lights of vehicles traveling from the opposite direction (Bozorg, 2019). Because if the driver only relies on the lighting from the vehicle's headlights, the vehicle's lights from the opposite direction can dazzle their eyes. This can cause the eyes to lose focus which can cause the driver to lose control. Therefore, road lighting is still important even if the vehicle has built-in lights. Moreover, the lights of the vehicles have a more limited light than road lamps.

2.2 Road user safety

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A journal entitled Road Safety in Low-Income Countries: State of Knowledge and Future Directions explained that Spain is one example that a proper plan for national road safety can reduce traffic accidents significantly (Heydari, Hickford, Mcllroy, Turner, & Bachani, 2019). From this journal, we can interpret that road users' safety can be improved if traffic safety has been well planned. Of course, significantly reducing traffic accidents will require complex and detailed planning, but this will be commensurate with the safety and security that road users will obtain. One of the plans to increase the security and safety of road users that can be implemented is by improving or increasing road lighting for the safety of road users at night.

Road user behavior is a primary factor in the increasing traffic accident rates worldwide (Heydari, Hickford, Mcllroy, Turner, & Bachani, 2019). This means that besides other external factors, the behavior of road users is also a factor that plays a vital role in the safety of road users. Therefore, it can be concluded that road users significantly control their safety. Therefore, no matter the traffic conditions, road users must maintain their safety by doing business, such as wearing seat belts for car drivers or using helmets for motorcyclists.

Jalan Majalengka-Rajagaluh is a route that is often passed by two-wheeled vehicles, in which motorists are a part of vulnerable road users. More than half of the world's fatal traffic accidents occur in vulnerable road users, pedestrians, cyclists, and motorists (Ptak, 2019). Thus, as a part of vulnerable road users, motorcycle riders have a greater risk of having a fatal accident than 4-wheeled vehicles and more. Because many motorcycles pass Jalan Majalengka-Rajagaluh, the risk of fatal accidents must be reduced to decrease the rate of fatal traffic accidents for vulnerable road users.

Apart from drivers, pedestrians are also included as road users even though they do not use vehicles. Pedestrians who are vulnerable road users have a greater risk of being affected by accident than vehicle drivers, especially when it is dark. The risks of pedestrians at night increase because pedestrians may be too optimistic about crossing without thinking about the possibility of motorists not seeing them (Uttley & Fotios, 2017). This means the safety of pedestrians on the road is also affected by road lighting because it can help motorists' vision so they can be more alert if pedestrians are crossing.

The safety of road users is essential because the after-effects of a traffic accident on accident victims are enormous. Traffic accidents are a severe problem because accidents have caused many victims as well as caused property losses for treatment or rehabilitation and have taken many lives (Dayana, 2021). In addition, an accident can also psychologically impact the victim or the victim's relatives, which may cause trauma and other. Because of the after-effects that road users can get from traffic accidents, traffic accidents must be avoided as much as possible to maintain the safety of road users.

2.3 Road Safety and Safe Driving

Road safety must be improved to improve road users' safety, and one way is by driving carefully. Causes of accidents include driving at high speed and in a hurry, low visibility, violating traffic rules and not understanding traffic signs, carelessness, fatigue, consuming alcohol, and falling asleep while driving, which may be caused by poor road conditions and design (Malik, Jabbar, & Rashid, 2017). Because many of the factors that cause accidents are on the driver's side, the driver must make sure he is ready to drive the vehicle by avoiding the consumption of alcohol and medicine that cause sleepiness to drugs. In addition, riders must also be prepared for road conditions and weather that may be faced during the trip.

Besides the driver factors that can arise as the cause of accidents, traffic accidents can be caused by other external factors. One thing to be careful of as a cause of a decrease in the level of road safety that can cause an accident is the condition of the area that the driver will pass through. For example, if the area to be passed by the driver has sharp turns and steep descents to areas prone to landslides, then, of course, the road is more dangerous for the driver's safety. At the same time, safer roads emphasize the importance of planning, designing, and building safe infrastructure (Martinez, Sanchez, & Yañez-Pagans, 2019). For this reason, to build efficient traffic safety, it is necessary to pay attention to road conditions from the time of development planning.

Besides the condition of the driver, the age range of the driver can also affect aspects that might

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cause an accident. For example, factors such as inexperience, lack of skill, and risky driving habits in young drivers and visual, cognitive, and mobility impairments in older drivers have been associated with causes of accidents (Rolison, Regev, Moutari, & Feeney, 2018). That way, to maintain safety on the road, driving a motorized vehicle is unrecommended for those who do not have a driving license (SIM) because drivers who do not have a SIM are more likely to have less ability to drive than those who have a sim. In addition, if older drivers have poor eyesight, it would be better to use glasses to improve their vision. That way, if the driver can reduce the risk of accidents from himself by maintaining safety while driving, road safety will also be better.

While driving, drivers must pay attention to road signs to maintain safety. Prohibition signs function to prohibit or limit definite traffic actions to vehicles and pedestrians (Zhang, et al., 2021). Violation of prohibition signs can lead to accidents and danger because traffic signs have been designed in such a way for the safety of road users. In addition to prohibition signs, warning signs also play a role in maintaining road safety. These signs warn road users about possible hazards and extreme lanes so drivers can be more careful.

Awareness of the importance of safe driving must come from the drivers themself. Drivers must be informed about the risk of injury when reckless driving and violates traffic rules to help drivers understand and implement safe driving behavior (Salum, Kitali, Bwire, Hannibal, Sando, & Alluri, 2019). Because drivers need to be aware of the importance of safe driving to avoid ignoring various warnings. Even drivers can violate traffic rules without hesitation when rules are made for their safety, such as regulations for using helmets and seat belts. Therefore, the driver must understand that safe driving aims to maintain their safety.

Although driver awareness is prime to maintaining safe driving, road safety also affects road users. Even so, often road safety has yet to receive more attention. Even though deaths and injuries from traffic accidents are increasing, road safety still receives less attention from the government because traffic accident problems are not the agency's responsibility (Singh, 2017).

3. Methodology

The research method is a qualitative research method with perception analysis. The perceptions of road users regarding the impact of road lighting on road user safety, so the results of data processing in this study will be in the form of a description of the perception of road users. The data collection is located on Jalan Majalengka-Rajagaluh, Kab. Majalengka, West Java, Indonesia. The location was chosen to be the object of research because the road has minimal lighting with an extreme road structure.

On the other hand, this road is one of the routes used to connect Majalengka Regency with Cirebon Regency and City, which causes the road to be quite busy with high-speed vehicles. However, this research will focus more on road lighting. The subjects in this research are road users on Jalan Majalengka-Rajagaluh.



Figure 1. Research Location

Meanwhile, the variable used in this study is the perception of road users toward road lighting. Primary data comes from road users' perceptions obtained through questionnaires and observations regarding Jalan Majalengka-Rajagaluh. For the study, primary data was obtained from the perceptions of 50

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respondents through a questionnaire. The parameters used in the form are the perception of performance and importance level of road lighting with a scale of 1 to 10 from very unimportant and very dissatisfied to very important and very satisfied. Data processing is carried out by using the IPA (Importance Performance Analysis) method. Quadrant 1 (High Interest and High Satisfaction) variables are recommended to continue its performance. Quadrant 2 (Low Interest and High Satisfaction), means excessive performance. Quadrant 3 (Low Interest and Low Satisfaction) means low priority. Quadrant 4 (High interest and low satisfaction) means that it needs more concentration (Rifai, Prasetyo, & Rhismono, 2023) (Rifai, Prasetyo, & Rhismono, 2023).



Figure 2. Importance Performance Analysis

4. Results and Discussion

4.1 Respondent's Personal Information

Respondent's data are divided into gender, age, and the vehicle used when passing Jalan Majalengka-Rajagaluh. Based on the questionnaire results, all respondents who had passed Jalan Majalengka-Rajagaluh majority were female, the majority were aged ≤ 20 years, and the vehicles that were mostly used were motorbikes. While the least used vehicles are public vehicles, and the age of road users who rarely pass Jalan Majalengka Rajagaluh is over 60.

Variable	Category	Frequency	Percent	
Gender	Male	18	36%	
	Female	32	64%	
Age	≤ 20	19	38%	
	21-30	7	14%	
	31-40	5	10%	
	41-50	16	32%	
	51-60	2	4%	
	> 60	1	2%	
Vehicles Used	Car	22	44%	
	Motorcycle	26	52%	



Public Transportation 2

4%

4.2 The Importance and Performance Level of Road Lighting

As the questionnaire results, the variable that gets the highest importance value is the importance of road lighting to the driver's vision (9.76). In contrast, the one that gets the lowest level of importance is the importance of road lighting to vehicles on the exact directions (9.02). Meanwhile, at the level of satisfaction, the highest satisfaction is given to road users' satisfaction with road lighting for road users (6.38), and the lowest satisfaction is given to road users' satisfaction with road lighting for driver's vision (5.92).

Indicator	Ι	Р	G
Road lighting for road user's safety	9.72	6.38	-3,34
Road lighting on safe driving		6.22	-3,46
Road lighting on driving's comfort		6.34	-3,02
Road lighting on driving navigation		6.3	-2,94
Road lighting in avoiding the risk of road damage		6.04	-3,56
Road lighting to vehicles in the same direction	9.02	6.3	-2,72
Road lighting to vehicles from the opposite direction	9.5	6.08	-3,42
Road lighting to road crossers	9.68	6.2	-3,48
Road lighting on activities besides traffic-related	9.2	6.18	-3,02
Road lighting at crossroads	9.32	6	-3,32
Road lighting to sharp turns	9.68	5.96	-3,72
Road lighting to the bridge	9.54	6	-3,54
Road lighting to the uphill and downhill roads	9.42	5.94	-3,48
Road lighting to the rider's age	9.22	6.06	-3,16
Road lighting on driver's vision	9.76	5.92	-3,84
Road lighting to the driver's line of sight	9.66	5.98	-3,68
Road lighting to prohibition and warning signs	9.38	6.2	-3,18
Road lighting for pedestrians	9.58	6.06	-3,52
Road lighting to a road crowd	9.24	6.14	-3,1
Road lighting to road user's awareness	9.54	6.12	-3,42

Table 2. The importance and performance level of road lighting



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Figure 3. Importance Performance Analysis Diagram

As seen in table 2, the gap value from the level of performance and importance of road users is at a minus value, which indicates that the importance of road lighting is still unable to meet the needs of road users. Whereas in the display of Figure 3, most of the variables are in quadrant IV, which indicates that many variables still require more concentration to increase. Even so, there are enough variables that need to be maintained.

4.3 Suggestion for Jalan Majalengka-Rajagaluh

Respondents were asked questions about whether an improvement was needed on Jalan Majalengka-Rajagaluh. The scale is 1 to 5, from very unnecessary to very necessary. The variables given are an improvement in road lighting and road-users-and-road-safety-related.



Figure 4. Road Improvement Diagram

Figure 4 shows that 89% of road users give a 5 for the three variables. The majority of respondents had a uniform answer, and no one gave a one or two, which means that the respondents think there is an excellent need for road improvements. Of the three variables, the one that gets the highest value or requires an improvement is an improvement in road lighting. In comparison, the results of the other two variables do not have many different levels of each other of the need for improvement but are still at high numbers. This indicates that road lighting should get priority in its improvement.

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5. Conclusion

From the research results, the level of importance of road lighting has an average of 9.47, which means that road lighting is essential. However, the level of road performance has only reached 6.12, so user satisfaction needs to be commensurate with the importance of road lighting. So that the resulting gap has an average of -3.35, the minus sign indicates that user satisfaction still needs to be fulfilled. That way, respondents expect an increase in road lighting. In addition, because motorbikes which are part of vulnerable road users, are the vehicles most used to pass Jalan Majalengka-Rajagaluh, it is necessary to increase the safety of road users and the safety of road users to reduce the risk of traffic accidents. In addition, the parameter considered the most important in road users' perception is road lighting for the driver's vision.

In contrast, the parameter considered less critical is the importance of road lighting for vehicles in the same direction. As for the level of satisfaction, the highest satisfaction is given to road users' satisfaction with road lighting for road users, and the lowest satisfaction is given to road users' satisfaction with road lighting for rider's vision. As for road improvement, all variables are deemed necessary to be improved.

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