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# ANALYSIS OF ROAD LIGHTING IMPACT ON ROAD USER SAFETY: CASE STUDY OF JALAN JATIBARANG - JATITUJUH

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*ABSTRACT*

*Despite the significant impact of street lighting on road user safety, there is a lack of monitoring for compliance with national standards (SNI) for many streetlights in West Java Provin The majority of accidents in the region result from factors such as overtaking, loss of vehicle control, tire blowouts, inadequate lighting, and unexplained incidents or brake failures. The Jatibarang-Jatitujuh Road is an example where lighting is neglected despite its susceptibility to high-speed traffic. The spacing between streetlights on this route, commonly used to connect Kabupaten and Kota Indramayu, is considerable, and tree branches obstruct some. Despite being a winding road prone to accidents, the Jatibarang-Jatitujuh Road remains busy with passing vehicles, especially at night. Poor street lighting contributes to the heightened risk for road users. Respondents express dissatisfaction with the illumination on the Jatibarang-Jatitujuh road, with an average satisfaction level of 6.73. Conversely, the importance level averages 9.1, indicating a high significance level and possibly exceeding respondents' expectations. The graphical analysis highlights vital indicators in each quadrant, with high-priority aspects including Road Lighting for safe driving, Road Lighting for road crossers, Road Lighting for road crowds, Road lighting for bridges, Road Lighting to mitigate the risk of road damage, Road Lighting for pedestrians, Road Lighting for uphill and downhill roads, and Road Lighting for driver's vision.*

## 1. Introduction

Illumination on roads is crucial for road users to enhance visibility at night or in dark situations. Even though darkness may not necessarily be the main reason for accidents, adequate street lighting can decrease the likelihood of traffic accidents resulting from reduced visibility of potential dangers. Additionally, the potential for traffic accidents is a global concern for diverse road users. Injuries resulting from road traffic accidents are a significant concern in global public health issues (Marchant, Hale, & Sadler, 2020). Traffic accidents are a leading cause of global deaths due to injuries and are projected to be among the top five causes of death by 2030.

In Indonesia, street lighting is already regulated by specific standards that must be met. If the illumination is inappropriate, it may be too bright, leading to excessive energy consumption and wasteful use of light. On the other hand, if the generated light is insufficient, it won't provide enough benefits for pedestrians. (Fotios & Gibbons, 2018). Hence, it is crucial that street lighting is appropriately designed to fulfill its intended purpose effectively. The standards for general road lighting in Indonesia are clearly outlined in the Indonesian National Standard (SNI) 7391:2008. Therefore, there should be no oversight or negligence in ensuring compliance with these road lighting standards in Indonesia. Adhering to these standards is essential to guarantee the safety of road users.

Even though street lighting has a big impact on the safety of road users, in West Java Province there are still many street lighting lamps whose compliance with SNI is not monitored. The majority of accidents are caused by overtaking other vehicles, loss of control over the driven vehicle, tire blowouts, inadequate lighting, and some accidents without a definite cause or brake failure(Muhammad, et al., 2017). Dim lighting is one of the factors contributing to accidents. However, street lamps that meet standards are often found only on major roads. Regardless of whether the road is large or small, road users still require proper lighting for safety. Incidents such as accidents, robberies, and even murders are more likely to occur on poorly illuminated streets and can be prevented with adequate lighting.

Like Majalengka Regency, well-lit roads are commonly found along major highways, while quieter streets often have minimal lighting. However, night-related accidents pose more significant dangers and are more severe. Research(Ashraf, Hur, Shafiq, & Park, 2019). shows that nighttime accidents lead to an 8.35% higher fatality rate than daytime accidents. Hence, providing adequate lighting is crucial for enhancing road user safety. On the contrary, road users in Majalengka frequently travel at high speeds on what they perceive as quieter roads. Therefore, it would be beneficial to ensure proper street lighting is evenly distributed, encompassing both main roads and quieter streets. This approach aims to mitigate the risks associated with nighttime accidents and promote overall road safety (Sumantri, Rifai, & Ferial, 2022).

One example where lighting is neglected, despite being prone to high-speed vehicles, is the Jatibarang-Jatitujuh Road. The distance between streetlights on this road, commonly used as one of the routes to Kabupaten and Kota Indramayu, is considerable, and tree branches obstruct some. Additionally, the dimness of some light bulbs and the fact that some bulbs must be fixed make the existing lights appear ineffective. Driving at night increases the likelihood of accidents more than other factors(Mphela, 2020). It signifies that the likelihood of accidents rises during the nighttime. However, given that the Jatibarang-Jatitujuh Road serves as a connection between two regencies, the road remains bustling with passing vehicles even during nighttime. Despite the road's winding nature and susceptibility to accidents, inadequate street lighting further adds to the risk for road users. The researcher is keen on composing a journal titled "Analysis of the Impact of Lighting on Road User Safety: A Case Study of the Jatibarang-Jatitujuh Road."

## 2. Literature Review

### 2.1 Road Lighting

In the realm of activities influencing sustainability and the environment, lighting has emerged as a noteworthy factor in recent years (Peña-García & Nguyen, 2018). The study results conclude that lighting has played a pivotal role in recent times. The purpose of lighting is to improve the visibility of road users, particularly during nighttime. In the absence of adequate lighting, awareness of potential road hazards diminishes in darkness, subsequently elevating the risk of accidents on the road.

Street lighting has been recognized as contributing to diminishing traffic accidents (Chenani, Räsänen, & Tetri, 2018). Among various approaches to reducing the incidence of traffic accidents, street lighting emerges as one effective method. Sanaz et al., in their journal titled "Advancement in Road Lighting," convey this idea. Therefore, although street lighting may not be the exclusive key factor in reducing nighttime traffic accidents, enhancing street lighting stands out as a proactive measure to mitigate risks on the road.

However, as in the case of street lighting on the Jatibarang-Jatitujuh Road, some lights on the road may not function properly at times. Issues such as light dispersion, the malfunctioning of light sources, and problems caused by trees can lead to variations in lighting distribution along different sections of the road(Yao Q. , Wang, Uttley, & Zhuang, 2018). Due to the frequent issues causing lamps not to function optimally, the condition of streetlights needs to be regularly monitored. This way, if any problematic lamps are identified, they can be promptly repaired. This ensures that existing street lighting can effectively fulfill its function.

While driving at night, vehicle headlights are indeed helpful; however, street lighting remains essential. We should not overlook the positive effects of street lighting on traffic safety and eye adjustment to headlights approaching from the opposite direction (Bozorg, 2019). Because if drivers rely solely on the illumination from vehicle headlights, the lights from oncoming vehicles can be blinding. This can cause the eyes to lose focus, leading to a loss of control for the driver. Therefore, street lighting remains crucial even if vehicles have their own headlights, especially since the lights on vehicles have a more limited range compared to streetlights.

## 2.2 Road User Safety

Spain serves as an example that well-planned road safety measures on national roads can significantly reduce traffic accidents. (Heydari, Hickford, Mcllroy, Turner, & Bachani, 2019). Enhancing traffic safety through well-thought-out planning can significantly contribute to the safety of road users. While achieving a substantial reduction in traffic accidents necessitates intricate and detailed planning, the effort invested is worthwhile for the safety and security of those using the road. One actionable initiative to improve road users' safety involves repairing or enhancing street lighting, mainly to ensure the safety of drivers during nighttime travel.

The behavior of road users is a primary factor in the increasing rates of traffic accidents worldwide. (Jameel & Evdorides, 2020). Correct. Besides external factors, the conduct of road users stands out as a pivotal element in ensuring road safety. Consequently, road users possess substantial control over their safety. Therefore, irrespective of prevailing traffic conditions, it remains imperative for road users to adopt safety measures, such as using seat belts for car drivers or helmets for motorcyclists, to safeguard their well-being.

Jatibarang-Jatitujuh Road is a route frequently used by two-wheeled vehicles, where motorcyclists fall into the category of vulnerable road users. More than half of fatal traffic accidents worldwide occur among vulnerable road users, including pedestrians, cyclists, and motorcyclists(Ptak, 2019). Indeed, motorcyclists, as vulnerable road users, face a higher risk of experiencing fatal accidents compared to drivers of four-wheeled vehicles and/or more. Given that Jatibarang-Jatitujuh Road is frequently used by motorcycles, efforts should be made to minimize the risk of fatal accidents, thus reducing the overall rate of fatal traffic accidents involving vulnerable road users.

Certainly, pedestrians are integral road users, even though they do not operate vehicles. As vulnerable road users, pedestrians face a heightened risk of accidents compared to vehicle drivers, particularly in low-light conditions such as nighttime. The risk for pedestrians escalates during the night as they might be overly optimistic about crossing without acknowledging the possibility that drivers may not easily spot them. This underscores the crucial role of street lighting and the importance of raising awareness among pedestrians and vehicle drivers to foster a safer environment for all road users(Uttley & Fotios, 2017). Yes, the safety of pedestrians on the road is indeed influenced by street lighting. Street lighting can enhance the visibility for drivers, enabling them to be more alert to the presence of pedestrians crossing the road.

Safety for road users is indeed a top priority, as the adverse effects experienced by traffic accident victims can be significant. Traffic accidents pose a serious problem as they result in numerous casualties, causing financial losses for medical treatment or rehabilitation, and claiming many lives(Dayana, 2021)In addition, accidents can also have psychological impacts on the victims and their relatives, potentially leading to trauma and other issues. Due to the negative consequences that road users can experience from traffic accidents, it is crucial to avoid accidents as much as possible to ensure road safety.

## 2.3 Road Safety and Safe Driving

To improve road user safety, it is essential to enhance road security, and one way to do so is by driving carefully. Some causes of accidents include driving at high speeds and in a hurry, limited visibility, traffic rule violations, lack of understanding of traffic signs, negligence and fatigue, alcohol consumption, falling asleep while driving, poor road conditions and design, and adverse weather conditions. Avoiding these behaviors and increasing awareness of these risk factors can help reduce the incidence of traffic accidents(Malik, Jabbar, & Rashid, 2017). Since many factors causing accidents are within the control of drivers, they must ensure they are ready to operate a vehicle by avoiding alcohol consumption,

medications causing drowsiness, and narcotics. Additionally, drivers should be prepared for road conditions and weather during their journey.

In addition to factors related to drivers, traffic accidents can stem from various external elements. An aspect that needs careful consideration as a potential threat to road safety, capable of causing accidents, is the condition of the geographical area through which the driver is navigating. If the driver's route encompasses sharp turns, steep descents, or regions prone to landslides, the road becomes more difficult for the driver. Conversely, safer roads prioritize the significance of meticulous planning, thoughtful design, and the construction of secure infrastructure(Martinez, Sanchez, & Yañez-Pagans, 2019). With these reasons, to establish efficient traffic safety, the road conditions need to be considered from the planning phase of construction.

Besides the driver's condition, the age range of drivers can also influence aspects that may lead to accidents. Factors such as inexperience, lack of skill, and risky driving habits are associated with younger drivers, while vision impairment, cognitive issues, and reduced mobility are linked to older drivers as potential causes of accidents. (Rolison, Regev, Moutari, & Feeney, 2018). Therefore, to ensure safety on the road, driving a motor vehicle is not recommended for those without a valid driving license (SIM) because drivers without a valid license are more likely to have inadequate driving skills than those with a permit. Additionally, for older drivers with impaired vision, it is advisable to use corrective glasses to enhance vision capabilities, and so on. By doing this, road safety will improve overall if drivers can reduce the risk of accidents by prioritizing safety while driving.

While driving, drivers are required to adhere to existing traffic signs as an effort to maintain safety. Prohibitory signs serve to prohibit or restrict specific traffic actions for both vehicles and pedestrians (Zhang, et al., 2021). Disregarding prohibitory signs can heighten the risk of accidents or dangers since traffic signs are specifically designed for the safety of road users. Besides prohibitory signs, warning signs are crucial in upholding road safety. These signs are crafted to notify road users about potential hazards or challenging conditions, enabling drivers to exercise greater caution..

Recognition of the importance of safety while driving should originate from the drivers. Educating drivers about the elevated risk of injury associated with reckless driving or disregarding traffic rules is essential. This education aims to foster understanding and encourage drivers to adopt safe driving behaviors.(Salum, Kitali, Bwire, Hannibal, Sando, & Alluri, 2019). Because drivers need to gain awareness of the importance of safety while driving, they may ignore various warnings. Drivers may even violate traffic rules made for their safety, such as regulations regarding helmets and seat belts. Therefore, drivers must understand that road safety aims to ensure their safety.

While driver awareness is crucial for maintaining road safety, road safety also affects road users. However, road safety often needs to receive more attention. Despite the increasing number of deaths and injuries due to traffic accidents, road safety is not the responsibility of a specific agency, and it requires more attention from the government. (Singh, 2017).

## 3. Method

The research method employed in this study is qualitative research with perception analysis to analyze road users' perceptions regarding the impact of road lighting on road safety. Consequently, the data processing results in this research will be in the form of descriptions based on the perceived outcomes received by the researcher. Data was collected on Jatibarang-Jatitujuh Road, Majalengka Regency, West Java, Indonesia.

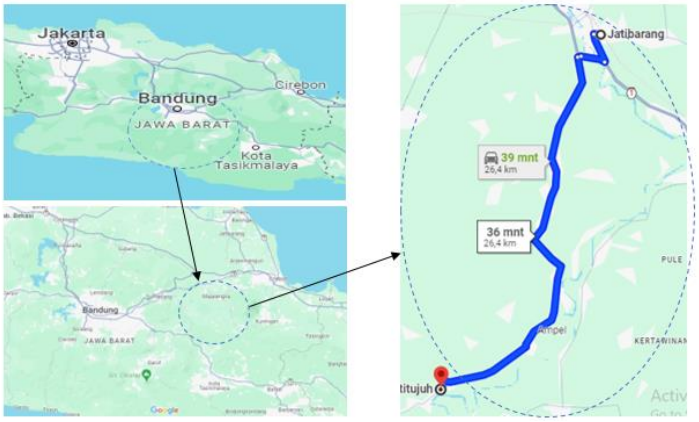


**Figure 1.** Research Location

The chosen location is the research object because the road has minimal lighting with winding road structures. On the other hand, this road is a major route connecting Majalengka Regency with Indramayu Regency and City, resulting in a busy road with high-speed vehicles. However, this research will primarily focus on road lighting. The subjects in this study are road users on Jatibarang-Jatitujuh Road. The variable in this research is road users' perceptions of road lighting. Primary data is sourced from the perceptions of 50 respondents obtained through questionnaires and observations of Jatibarang-Jatitujuh Road. In this study, preliminary data is obtained from the perceptions of 50 respondents through questionnaires. The parameters used range from 1 to 10, indicating the importance and satisfaction of respondents regarding aspects influenced by road lighting, ranging 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).

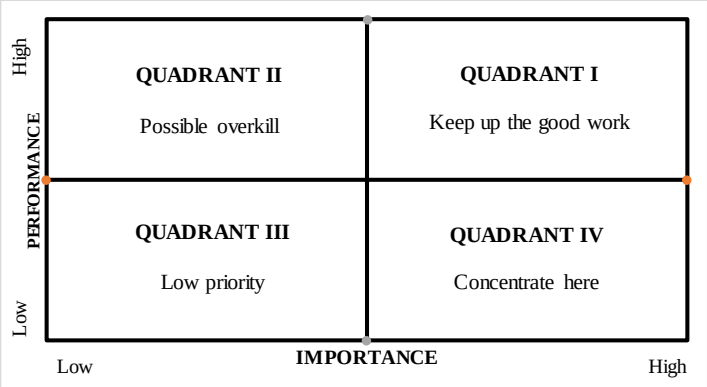


**Figure 2.** Importance Performance Analysis

## 4. Result and Discussion

### 4.1 Respondent's Personal Information

The responses from the questionnaire need to be rearranged or grouped first. The purpose of this grouping is to enable readers to understand a summary of the respondents and to grasp the accompanying data. These respondents are specifically targeted at individuals or drivers who have traversed the Jatibarang-Jatitujuh road, with a summary based on 50 respondents.

**Table 1.** Responden Personal Information

| No. | Characteristics | | Frequency | Value (%) |
|---|---|---|---|---|
| 1 | Gender | Man | 38 | 76 |
| | | Woman | 12 | 24 |
| 2 | Age | <20 | 14 | 28 |
| | | 21-30 | 20 | 40 |
| | | 31-40 | 9 | 18 |
| | | 41-50 | 3 | 6 |
| | | 51-60 | 3 | 6 |
| | | >60 | 1 | 2 |
| 3 | Vehicles Used | Car | 21 | 42 |
| | | Motorcycle | 29 | 58 |

### 4.2 The Importance and Performance Level of Road Lighting

After summarizing the respondent data, the next step is to compile the total and average of the questionnaire results. This data will be further processed to create an IPA (Importance-Performance Analysis) graph, determining the priority levels in the context of road lighting based on the questionnaire data. The questionnaire summary, organized according to the indicators queried in the questionnaire, is presented in the table below.

**Table 2.** The Importance and Performance level of road lighting

| Code | Indicator | I | P | G |
|---|---|---|---|---|
| A1 | Road Lighting for road user's safety | 7.14 | 6.5 | -0.64 |
| A2 | Road Lighting on safe driving | 9.68 | 6.66 | -3.02 |
| A3 | Road Lighting on driving's comfort | 8.73 | 6.8 | -1.93 |
| A4 | Road Lighting on driving navigation | 7.89 | 7.18 | -0.71 |
| A5 | Road Lighting in avoiding the risk of road damage | 9.35 | 6.54 | -2.81 |
| A6 | Road Lighting to vehicles in the same direction | 7.69 | 6.78 | -0.91 |
| A7 | Road Lighting to vehicles from opposite direction | 8.99 | 6.76 | -2.23 |
| A8 | Road Lighting to road crossers | 9.45 | 6.7 | -2.75 |
| A9 | Road Lighting on activities besides traffic-related | 9.34 | 6.76 | -2.58 |
| A10 | Road Lighting at croassrodads | 9.36 | 7.22 | -2.14 |
| A11 | Road Lighting to sharp turns | 9.27 | 6.82 | -2.45 |
| A12 | Road lighting to the bridge | 9.49 | 6.5 | -2.99 |
| A13 | Road Lighting to the uphill and downhill roads | 9.87 | 6.54 | -3.33 |
| A14 | Road Lighting to the rider's age | 9.95 | 6.72 | -3.23 |
| A15 | Road Lighting on driver's vision | 9.32 | 6.38 | -2.94 |
| A16 | Road Lighting to driver's line of sight | 9.64 | 7.22 | -2.42 |
| A17 | Road Lighting to prohibition and warning signs' | 9.55 | 6.76 | -2.79 |
| A18 | Road Lighting for pedestrians | 9.23 | 6.5 | -2.73 |
| A19 | Road Lighting ti a road crowd | 9.12 | 6.66 | -2.46 |
| A20 | Road Lighting to road user's awarness | 9.03 | 6.56 | -2.47 |

| | | | |
|---|---|---|---|
| AVERAGE | 9.1 | 6.73 | -2.38 |

Based on the table above, variables were obtained according to the indicators queried. The importance variable's average value is 9.1, inversely proportional to the performance value with an average of 6.73. Thus, the smaller performance value compared to the importance value suggests that the respondents' satisfaction or performance regarding lighting on the Jatibarang-Jatitujuh road is significantly lower than the level of importance assigned by the respondents. The negative GAP values also indicate a significant shortfall, highlighting the need for the government to listen to the community's aspirations regarding the lighting on the Jatibarang-Jatitujuh road.

After generating and summarizing the averages for each variable in each indicator, including obtaining the existing GAP values, the next step is to create an Importance and Performance Analysis (IPA) graph to determine the prioritization level for improving the lighting on the Jatibarang-Jatitujuh road. The IPA method graph is presented in the image below.

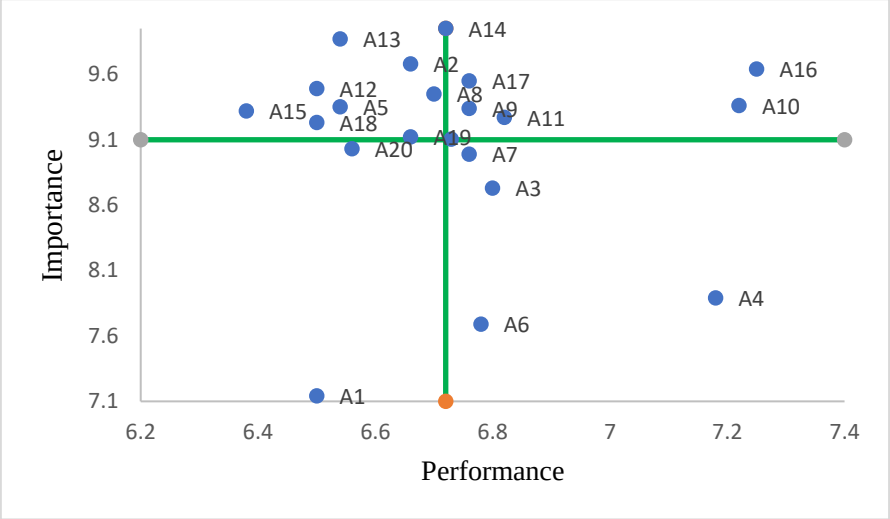


**Figure 3.** Importance and Performance Analysis

Based on the above graph, there are several indicators in each quadrant, and each quadrant has its meaning and results. In quadrant 1, several indicators exist A14, A8, A9, A11, A10, A16, and A17. In this quadrant, respondents have demonstrated a balanced level of satisfaction and importance that needs to be maintained. On the other hand, in quadrant 2, there are several indicators, including A2, A8, A10, A5, A13, A12, A15, and A18. Quadrant II represents respondents who feel very dissatisfied with the indicators in this quadrant, making it the top priority to improve the lighting on the Jatibarang-Jatitujuh road. Meanwhile, in quadrant III, there are two indicators, namely A20 and A1, where this quadrant represents the second priority for improving road lighting. As for quadrant IV, there are four indicators: A4, A6, A3, and A7, which indicate low priority for improvement in road lighting.

## 6. Conclusion

This research utilizes questionnaire data as the primary data to present the study. The data includes variables related to the satisfaction and importance levels of respondents who traverse the Jatibarang-Jatitujuh road. Fifty individuals with diverse characteristics filled out the questionnaire regarding age, gender, and the type of vehicle used. On average, the satisfaction level of respondents in the indicator regarding road lighting on the Jatibarang-Jatitujuh road is 6.73, indicating that respondents are somewhat dissatisfied with the lighting. On the other hand, the importance level has an average value of 9.1, considered very high in terms of importance or even the respondents' expectations. The graphical

results reveal several indicators in each quadrant. High-priority indicators include Road Lighting for safe driving, Road Lighting to road crossers, Road Lighting a road crowd, Road lighting the bridge, Road Lighting to avoid the risk of road damage, Road Lighting for pedestrians, Road Lighting uphill and downhill roads, and Road Lighting on driver's vision.

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