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# Evaluation of The Lack Of Street Lighting: Case Study of Tonjong Roundabout

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***ABSTRACT***

*Street lighting is installed along roads so people can see better at night. To increase road safety and lower accident rates, international organizations like the WHO have underlined the significance of adequate infrastructure, such as street lighting. As part of their efforts to reduce the number of traffic accidents across the country, the government and authorities are paying special attention to the lack of street lighting. The lighting conditions on the road connecting Jatiwangi with Majalengka city, specifically the Tonjong roundabout, still require maximum street lighting. Tonjong Roundabout is located in Majalengka Regency, which connects the Jatiwangi road section with the city of Majalengka. The questionnaire approach is the research methodology employed in this study. Crime rates and injuries from accidents increase due to a lack of street lighting, especially in developing countries, where investment in infrastructure is often limited. In some places, rapid urban growth is not matched by adequate infrastructure development, including sound lighting systems. A comprehensive evaluation of street lighting conditions at the local level will allow for implementing more targeted solutions that improve safety and comfort for all who use the roads. The study's findings indicated that street lighting had an average relevance rating of 1.34. Nonetheless, the average level of satisfaction with street illumination was 2.55; the difference between importance and satisfaction was -1.21. Up to 95% of respondents then anticipate that street lighting will be improved for increased driving safety.*

## 1. Introduction

Many countries around the world face the problem of poor street lighting. Street lighting is crucial to increase road users' visibility at night or in low light (Candra & Savitri, 2024). International organizations such as WHO and the UN have emphasized the importance of good infrastructure, such as street lighting, to improve traffic safety and reduce accidents. Traffic accidents are among the most dangerous dangers for humans (Santos, Saias, & Nogueira, 2021). They found that crime rates and injuries from accidents increased due to a lack of street lighting, especially in developing countries, where investment in infrastructure is often limited. Finally, street lighting is a policy that can be directly influenced by the community and has the potential to be used to target high-crime areas where most of the crime in a city is concentrated (Chalfin, Hansen, & Parker, 2022). Street lighting conditions at the regional level often vary depending on policies and resources. In some places, rapid urban growth is not matched by adequate infrastructure development, including sound lighting systems. Global economic growth and the movement of people depend heavily on road infrastructure (Reta, Rifai, & Prasetijo, 2024). This results in many dark roads at night, increasing the risk of accidents and crime. These factors include poor lighting, unexpected moments, road surface, lack of alertness, and driver age (Vaiyapuri & Gupta, 2021).

As the population grows and the number of vehicles continues to increase, this problem is becoming increasingly important in some places, such as Southeast Asia. As part of their efforts to reduce the number of traffic accidents across the country, the government and authorities are paying special attention to the lack of street lighting. Traffic accidents on urban roads are unavoidable in urban transportation, causing serious injuries and property losses (Cai, 2020). Improving street lighting is a solution often offered by traffic safety programs. It is hoped that best practices in road maintenance that comply with international standards will be implemented by following Bina Marga's instructions, improving the condition of road infrastructure worldwide (Kharisma, Rifai, & Prasetijo, 2024). However, the implementation and success of these programs are often hampered by budget issues and poor planning. As a result, many areas across the country still face significant problems with road safety, especially in underserved areas.

Not all street lighting in Majalengka has good lighting; only some have maximum lighting. It does many important things, such as maintaining traffic and pedestrian safety and preventing crime (Welsh, Farrington, & Douglas, 2022). Many communities face the problem of inadequate lighting, especially in residential areas and on footpaths. This disrupts people's mobility and makes them feel unsafe outside the house at night. This is an essential concern for the driver's safety (Nurhasanah, Rifai, Taufik, & Isradi, 2024). A comprehensive evaluation of street lighting conditions at the local level will allow for implementing more targeted solutions that improve safety and comfort for all who use the roads. The lighting conditions on the road connecting Jatiwangi with Majalengka city, specifically the Tonjong roundabout, still require maximum street lighting. Street lighting is essential for road users. If we look directly at the night conditions at the Tonjong roundabout, it is jam-packed with motorists and road users. So, planning and maintaining the Tonjong roundabout street lights will improve traffic safety and the security of road users from accidents or criminal activities.

## 2. Literature Review

### 2.1 Lighting

Human life is very dependent on lighting. Lighting includes the use of light, both artificial and natural, to achieve a purpose. Studies show that lighting has a significant effect on human psychology, physiology, and behavior, in addition to its function of illuminating an infrastructure. Lighting, which includes light distribution, color, and brightness, can affect mood, productivity, and health. Lighting, which provides for light distribution, color, and brightness, can affect mood, productivity, and health. Lighting conditions significantly impact all human life and health (Konstantzos, Sadeghi, Kim, & Tzempelikos, 2020). Humans have relied on natural lighting, such as sunlight, for many years. However, with the advancement of technology, artificial lighting is increasingly dominating. The literature study looks at the advantages and disadvantages of these two types of lighting. Natural light increases vitamin D production and regulates circadian rhythms. In contrast, artificial lighting gives you more freedom to adjust the intensity and color of the light. A new study suggests that combining natural and artificial lighting can make human environments work best. Another disadvantage is related to the quality of lighting (de Souza, da Silva, Fontenele, Barbosa, & de Oliveira Jesus, 2019).

Lighting impacts on human health. In addition, roads also have an impact on all economic activities in Indonesia (Anugraha & Rifai, 2024, October). For example, exposure to blue light from electronic devices at night can interfere with melatonin production and disrupt sleep. Additionally, being too bright or too dark can cause headaches and eye strain. On the other hand, proper lighting can improve mood, reduce stress, and increase productivity. Recent studies have also shown that cognitive performance and learning can be affected by lighting. Luminescence impressions and mood states are two primary components of the judgment pathway, and more researchers have begun to investigate them (Kong, Liu, Li, & Xing, 2022).

In architecture, lighting is essential. Good lighting design can create a pleasant atmosphere, increase energy efficiency, and enhance critical architectural elements. To get the best results, this geometric planning must also be done correctly (Pernama, Rifa'i, & Fajarika, 2024). Reflective building materials and intelligent lighting systems can improve lighting inside buildings and infrastructure. Lighting can also produce optical illusions and dramatic effects. Therefore, lighting is essential to highlight a building and help various activities around it (Bista et al., 2021). The lighting industry continues to grow at a tremendous pace. The latest trends are the use of LED technology, bright lighting that can be controlled automatically, and the integration of lighting into other building systems. This phenomenon is reflected in population numbers, economic growth, and infrastructure development (Wagiman, Abdullah, Hassan, & Kwang, 2020). As previous research has shown, these technologies offer a variety of benefits, including higher energy efficiency, greater flexibility, and better user experience. In addition, research continues to develop lighting systems that can be adapted to user needs and environmental conditions.

## 2.2 Street Lighting

Street lighting is a lighting system installed along roads so people can see better at night. Meanwhile, traffic space, or regulation, includes road infrastructure, lights, and traffic laws (Fatimah & Rifa'i, 2024). Street lighting mainly aims to improve road users' safety, both vehicle drivers and pedestrians. Studies have shown that adequate street lighting helps reduce the number of traffic accidents, especially at night. The primary purpose of road lighting is to enhance the visibility of an automobile's headlights (Ergüzel, 2019). Street lighting can also improve environmental safety and provide a sense of comfort for the community. Light sources, control systems, and brightness levels are some ways street lighting can be categorized. In general, there are two main categories of street lighting: conventional lighting, which uses conventional lamps such as incandescent or fluorescent lamps. Bright lighting, on the other hand, uses LED technology and control systems integrated with sensors and communication networks. One of this application's features is setting a schedule for when the lights should be turned on or off (Putrada, Abdurohman, Perdana, & Nuha, 2022). As research has shown, bright lighting has many advantages, including high energy efficiency, longer service life, and the ability to adapt to various environments.

Each country has standards and regulations regarding street lighting. These standards regulate brightness levels, light distribution, and the height of lamp posts. When lighting is inadequate, people will be less alert to potential dangers on the road at night, thus increasing the likelihood of accidents (Candra & Savitri, 2024). The purpose of this standard is to ensure that street lighting meets road users' safety and comfort needs. In addition, IoT technology also provides driving comfort and safety services for drivers (Chiradeja, Yoomak, & Ngaopitakkul, 2020). Studies have shown that street lighting that meets standards can improve people's quality of life and support road regulations.

The technology used for street lighting is developing rapidly. Energy-efficient (LED) lighting has been used to upgrade streets in recent years (Anthopoulou & Doulos, 2019, September). Use LED lights with customizable colors, integration with monitoring systems, and energy utilization. With the advantages of being small, durable, and energy efficient, LEDs can replace many conventional lamps (Woo et al., 2022). Literature studies show that these technologies can reduce operational costs, increase safety, and are environmentally friendly.

Although there has been much progress in street lighting, some issues still need to be addressed. One of the main problems is the high investment cost, especially when using innovative technology. In addition, the maintenance and care of street lighting systems is also costly. Maintenance is a set of actions (such as cleaning, repair, replacement, etc.) to increase a system's effectiveness and security

while in operation (Ikuzwe, Ye, & Xia, 2020). Studies show that governments, industry, and academia must collaborate to develop new and sustainable solutions.

### 2.3 Traffic

The flow of people and products via different modes of transportation is referred to as traffic. Human social, economic, and cultural life are significantly impacted by traffic. Road infrastructure development has been carried out in several countries to meet the need for adequate roads (Purnama, Savitri, & Fajarika, 2024). An effective transportation system can increase productivity, expand accessibility, and support economic growth. The latest advances in automotive technology will fundamentally change the traffic system (Ye & Yamamoto, 2019). However, increased traffic volume can cause various problems, including congestion, accidents, and air pollution.

The quality of a traffic system can be influenced by several factors. Both physical and non-physical. Road conditions, road capacity, and number of vehicles are physical factors. Government policies, population density, and driver conduct are examples of non-physical causes. In many nations, traffic congestion is worsening, particularly in larger cities with growing cars. This has a detrimental effect on the local economy and social progress (Zadobrischi, Cosovanu, & Dimian, 2020). Literature studies show that the relationships between these components can be very complex and unpredictable.

Traffic accidents are a common problem in urban areas. Numerous factors, such as driving too fast and in a hurry, poor road conditions and design, poor visibility, breaking traffic regulations, failing to understand traffic signals, being careless and tired, drinking alcohol, falling asleep while driving, and unfavorable weather, can result in accidents (Candra & Savitri, 2024). Studies show that traffic jams can cause many disadvantages, including spending more time, consuming more fuel, and emitting more exhaust fumesOther significant adverse effects of traffic congestion include lost time, especially during rush hour, psychological stress, and additional pollutants that contribute to global warming (Akhtar & Moridpour, 2021). Some leading causes of congestion include uncontrolled vehicle growth, inadequate spatial planning, and lack of public transport infrastructure. Therefore, traffic volume will increase gradually shortly. The government will not be able to manage traffic effectively or create a safer road transport environment without a thorough understanding of the severity of accidents (Wang, Liu, Ma, Zhang, & Cong, 2019).

Researchers have offered various solutions to traffic problems. Development of better public transportation, implementation of intelligent traffic management systems, and encouraging the use of alternative transportation. As a result, research is concentrated on improving transportation systems' sustainability, efficiency, and traffic congestion (Ling, Ma, & Jia, 2022). For example, bicycles and walking are some of the solutions commonly discussed in the literature. Integrated space planning is also essential to reduce dependence on cars. Traffic studies continue to evolve. Traffic behavior is the volume, speed, and density of traffic flow inferred from provided historical and real-time data (Alghamdi, Mostafi, Abdelkader, & Elgazzar, 2022). Some of the most recent study trends include the development of driverless vehicles, information, and communication technology to control traffic, and studies on driver behavior. Studies show that technology can improve the safety and efficiency of transportation systems. One of the initial steps in implementing an effective traffic management system or reducing congestion is to monitor traffic flow in an area (Afrin & Yodo, 2020).

## 3. Research Methods

The questionnaire approach is the research methodology adopted in this investigation. The questionnaire method is a set of written questions for respondents to answer. Respondents' answers are then collected and analyzed to obtain the required information. Researchers find it difficult to find a common understanding of this phenomenon (Grassini & Laumann, 2020). This data was collected by

asking everyone around Tonjong Roundabout questions. This research data shows how road users perceive street lighting impacting road user safety and security. The illumination quality of the Jatiwangi route that connects Majalengka, namely at the Tonjong Roundabout, was assessed in this study using the road user perception variable. The primary data were obtained from a questionnaire sent to 21 people who used the road. On a scale of 1 to 4, which goes from not relevant to extremely important and from unsatisfied to highly satisfied, the respondents' opinions of the significance and level of satisfaction with street lighting on this road were evaluated. Tonjong Roundabout is located in Majalengka Regency, which connects the Jatiwangi road section with the city of Majalengka. The number of people who often pass through the roundabout causes many comments from road users if they pass through it at night. Many people usually have accidents due to a lack of street lighting. The research location is on the Jatiwangi road connecting the city of Majalengka, precisely at the Tonjong roundabout. **Figure 1.** shows the research location.

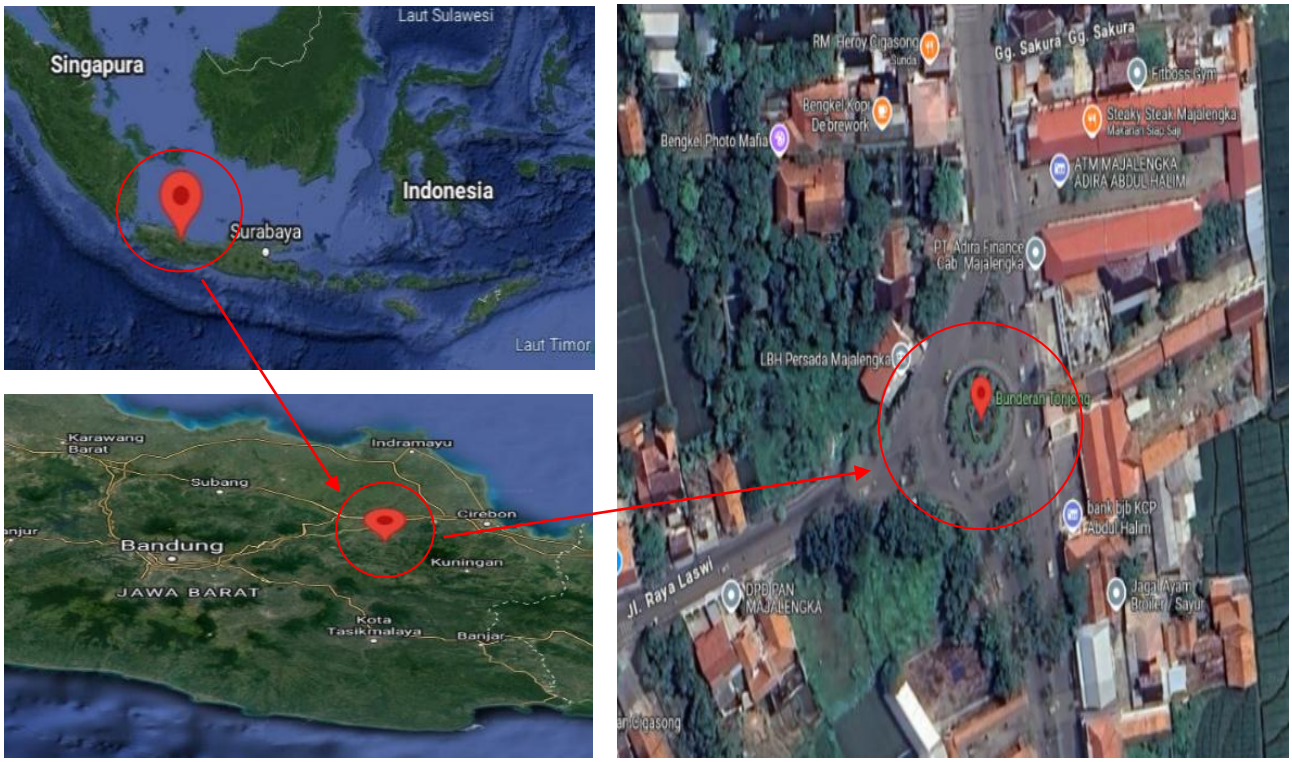
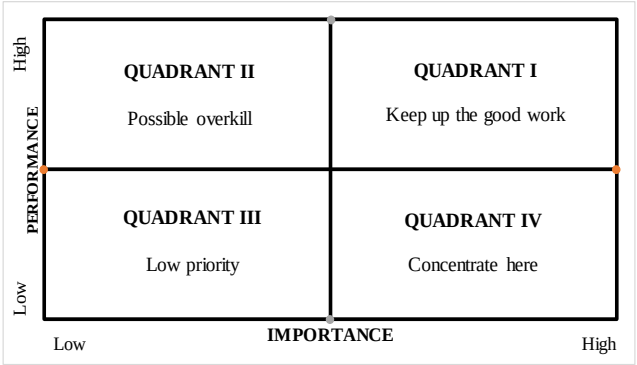



**Figure 1.** Research Site




Importance Performance Analysis (IPA) method processes data. The firm will utilize this strategy to identify essential performance elements and develop a priority scale for meeting customer

satisfaction. The four-quadrant method is typically used in Importance Performance Analysis (IPA). A very high degree of pleasure is indicated by quadrant I, which is crucial to preserve. Despite having less relevance, Quadrant II has the same high degree of satisfaction. Quadrant III displays the quadrant with the same low degree of significance and satisfaction. And quadrant IV denotes a very high degree of importance and enjoyment.

## 4. Results and Discussion

### 4.1 Respondent Information

Respondent data was categorized by age, gender, and kind of vehicle utilized to traverse the Tonjong Roundabout. The results show that all respondents have passed through Tonjong Roundabout, with the majority being male and aged between 21 and 30 years. The most frequently used vehicle is a motorbike, the least commonly used vehicle is a car, and the least frequently used road users are between 41 and 50 years old.

**Table 1.** Respondent Information

| Variable | Category | Frequency | Per cent |
|---|---|---|---|
| Crossing the Roundabout in Tonjong | Once | 21 | 100% |
| | Never | 0 | 0 |
| Gender | Male | 16 | 76,2% |
| | Female | 5 | 23,8% |
| Age | Less than - 20 Years | 5 | 23,8% |
| | 21 - 30 Years | 13 | 61,9% |
| | 31 - 40 Years | 2 | 9,5% |
| | 41 - 50 Years | 1 | 4,8% |
| | 51 - 60 Years | 0 | 0 |
| | More than 60 Years | 0 | 0 |
| Vehicles Used | Motorcycle | 15 | 76,2% |
| | Car | 5 | 23,8% |

**Table 2**. Level of Importance and Satisfaction With Street Lighting

| Code | Indicator | Indicator | Average Interest | Average Satisfaction | Difference |
|---|---|---|---|---|---|
| C1 | How important is street lighting for your safety? | Satisfaction with the Tonjong roundabout street lighting for driving comfort? | 1,05 | 2,57 | 1,52 |
| C2 | How important is street lighting to prevent crime? | Satisfaction with the Tonjong roundabout street lighting regarding the risk of avoiding road damage? | 1,19 | 2,38 | 1,19 |
| C3 | How important is road lighting for driving comfort? | Satisfaction with the Tonjong roundabout street lighting for driving comfort? | 1,19 | 2,57 | 1,38 |
| C4 | How important is road lighting for visibility while driving? | Satisfaction with the Tonjong roundabout street lighting regarding the risk of avoiding road damage? | 1,42 | 2,66 | 1,24 |

| | | | | | |
|---|---|---|---|---|---|
| C5 | How important is road lighting for seeing oncoming vehicles? | Is the road lighting at the Tonjong roundabout adequate for cars traveling in the same direction? | 1,42 | 2,38 | 0,96 |
| C6 | How important is road lighting in seeing vehicles from the same direction? | Is the road lighting at the Tonjong roundabout adequate for cars traveling in the other direction? | 1,57 | 2,66 | 1,09 |
| C7 | How important is street lighting for activities other than driving? | Satisfaction with the Tonjong roundabout street lighting for pedestrians? | 1,42 | 2,71 | 1,29 |
| C8 | How important is street lighting to prevent road damage? | Satisfaction with the Tonjong roundabout street lighting towards the intersection? | 1,33 | 2,52 | 1,19 |
| C9 | How important is street lighting on the road to the roundabout? | Satisfaction with the Tonjong roundabout road lighting on the bends? | 1,42 | 2,57 | 1,15 |
| C10 | How important is lighting at the roundabout? | Satisfaction with the Tonjong roundabout road lighting regarding drivers' visibility? | 1,42 | 2,57 | 1,15 |

## 4.2 Level of Importance and Satisfaction With Street Lighting

Data is required from two respondents, who are road users who frequently pass through the location. One theory of assessment in questionnaire data management is belief, which is a grouping based on quality. By using this theory, the research can group the questionnaire results based on the type of questionnaire questions and the results of road user assessments using this research questionnaire. Compiling the entire questionnaire results and calculating the average comes next, following the summarization of respondent data. The information from the questionnaire will be used to generate an IPA (Importance-Performance Analysis) graph that establishes the priority level concerning street lighting. The following table presents a summary of the questionnaire, arranged according to the questioned indicators. The data processing tool used to gauge how essential and satisfied road users are with the Tonjong Roundabout's lack of lighting is displayed in Table 2.

## 4.3 Importance Performance Analysis (IPA)

The next stage is to use the Importance and Performance Analysis (IPA) approach to build a graph after calculating and summarizing the average of each variable on each indicator, including the current difference value. The graphic below displays the science method graph.

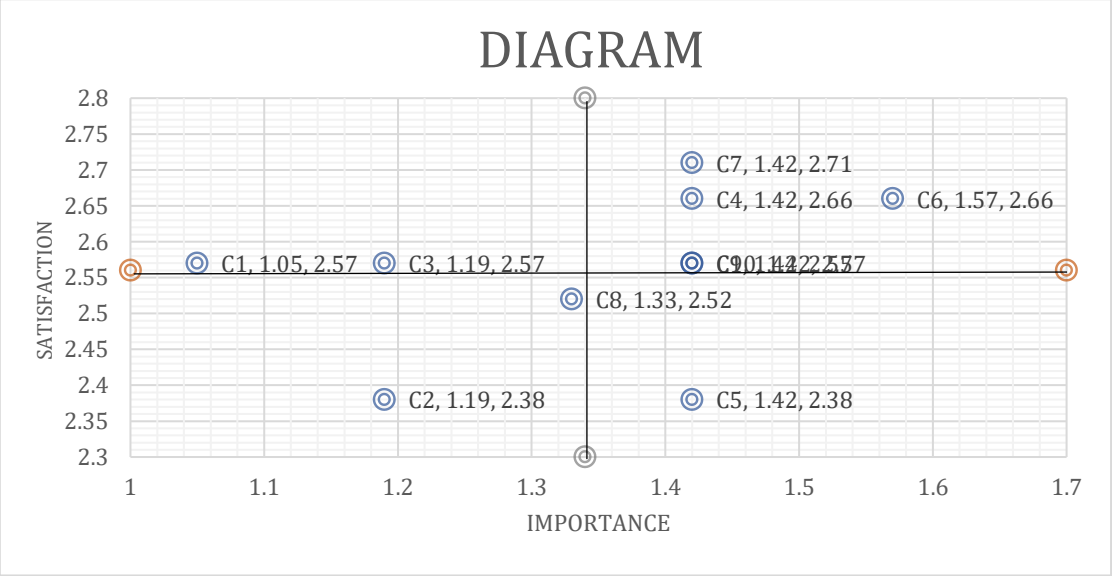



**Figure 2.** Analysis of Interest and Satisfaction

The graph above demonstrates that every quadrant has a distinct purpose and significance and contains a variety of indications. Indicators C7, C4, C6, C9, and C10 in quadrant 1 demonstrate that respondents exhibit a balanced degree of interest and contentment, which has to be sustained. The Tonjong roundabout's street illumination has to be improved immediately because responders in quadrant 2 are extremely unhappy with indicators C1 and C3. Enhancing street illumination at Tonjong Roundabout is the top priority since respondents in quadrant II are extremely unhappy with the indications in this quadrant, while indicators in quadrant III, specifically C2 and C8, rank second in importance. In quadrant IV, one indicator, namely C5, is a priority indicator for improving the street lighting at the Tonjong roundabout.

## 5. Conclusion

The study's findings indicated that street lighting had an average relevance rating of 1.34. Nonetheless, the average level of satisfaction with street illumination was 2.55; the difference between importance and satisfaction was -1.21. A negative number denotes the amount of street lighting that needs to be raised to balance road user interests with street illumination. Furthermore, motorbikes are the most common vehicle that connects the Jatiwangi road with Majalengka, particularly the Tonjong Roundabout, making them more susceptible to accidents and criminal activity. Additionally, street lighting is regarded as the most crucial factor for seeing cars coming from the same direction, and it receives the highest rating for preventing pedestrians from becoming invisible. Meanwhile, street lighting has the lowest degree of satisfaction about the risk of avoiding road damage, and illumination for purposes other than driving is regarded as not being particularly important. Up to 95% of respondents then anticipate that street lighting will be improved for increased driving safety.

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