Evaluation of Road Lighting Level on Road User Safety (Case Study of Majalengka Ring Road Section)

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ARTICLE INFO	ABSTRAK
Keyword: *Traffic* *Road User Safety* *Lighting*	*The evaluation of street lighting is a critical issue from a global traffic safety perspective. Different road lighting standards in different countries pose challenges to data comparison and effective policy implementation. Given the increasing number of traffic accidents in Indonesia, evaluating the level of road lighting is increasingly important. It is clear that there are significant differences between urban and rural areas in terms of street lighting. In an effort to improve traffic safety on the Majalengka Ring Road, evaluating the level of road lighting on road user safety is an important part. Given the high rate of traffic accidents on the Majalengka Ring Road, an assessment of the level of road lighting in relation to road user safety should be carried out immediately. The purpose of this study is to evaluate how drivers are impacted by the Majalengka Ring Road's position, which lacks an adequate street lighting system.. The site of this research was located on the Ring Road of the Majalengka. This research uses qualitative methods with perception analysis. The main data from the questionnaire given to 40 people who use Majalengka Ring Road. People were asked how important and satisfied they were with the street lighting on this road. They could choose from 1 to 5, from not important to very important, and from dissatisfied to very satisfied. The method used to process data is Importance Performance Analysis (IPA). The results of this study are expected to provide solutions and changes for future spatial planning, which will result in improved infrastructure and various other aspects, especially on the public street lighting of road users, as well as improve the safety, comfort and overall quality of life of the community.*

1. Introduction

The evaluation of street lighting is a very important issue from a global traffic safety perspective. An important factor in determining a nation's ranking in the Global Competitiveness Index (GCI) is its infrastructure [1]. Different street lighting standards in different countries pose challenges to data comparison and effective policy implementation. Disparities between urban and rural areas in light quality also exacerbate this problem. These challenges are compounded by the lack of access to good lighting between urban and rural areas. International comparative studies provide valuable insights for developing more consistent global standards and improving road safety around the world. It is believed that knowledge gained in nations with low accident rates may be applied to those where vulnerable road users continue to face a high risk[2].

Similar difficulties in controlling traffic and guaranteeing the safety of road users are present in Indonesia at the national level [3]. Given the increasing number of traffic accidents in Indonesia, evaluating the level of street lighting is increasingly important. It is clear that there is a significant difference between urban and rural areas in terms of street lighting. In an era of fast changing, highly populated cities, several experts have highlighted the importance of night-time lighting design for urban sustainability and the enhancement of social well-being in the city. [4]. The level of road user safety varies due to non-uniform lighting standards across the region. Therefore, a thorough evaluation needs to be conducted to determine locations that require improved street lighting to reduce the risk of accidents. The primary goal of lighting installation is to provide drivers with the proper level of safety and well-being[5].

Many Indonesian hamlets, particularly those in West Java, are unaware of the significance the role of the Community in fostering the construction of infrastructure and amenities [6]. In an effort to improve traffic safety on the Majalengka Ring Road, evaluating the level of road lighting on road user safety is an important part. This study shows that inadequate lighting can increase the likelihood of accidents, especially at night when visibility is limited. Generally speaking, governments may lessen the severity of traffic accidents by changing the behavior of drivers or enhancing the state of the roads [7]. Based on the SNI 7391:2008 standard, many installed street lights do not meet the required lighting criteria, so the PJU system must be reorganised. Analysis of current conditions shows that the distance between lampposts often does not match the standard, which can reduce the effectiveness of lighting. Therefore, suggestions to improve street lighting should be considered to make roads safer for everyone in the area.

Given the high rate of traffic accidents on the Majalengka Ring Road, an assessment of the level of street lighting in relation to road user safety should be carried out immediately. Because serious crimes like robbery, assault, and battery typically happen at night, there is a great deal of public fear about nighttime crimes in our culture [8]. This research shows that inadequate lighting significantly increases the risk of accidents, especially at night when visibility is very low. As far as the distance between poles and the intensity of light produced, many of the installed street lighting lamps do not meet SNI standards. This causes motorists and pedestrians to feel unsafe when travelling on these roads. Therefore, recommendations on improving a more efficient lighting system are needed to increase the safety and comfort of road users in Majalengka. Building supporting infrastructure from a road is one way to enhance road infrastructure [9].

A highway design is considered "successful" if it can be implemented in a way that gives each user of the road a sense of security and comfort, therefore fulfilling the highway's primary function of facilitating people's daily activities [10]. Traffic management can be used in several ways to optimise the transport system. The goal of traffic management is to improve traffic effectiveness while reducing disruption and congestion. Traffic management also ensures road safety and public health. Many traffic management techniques are also intended for other objectives. For example, speed limits are sometimes set for safety or traffic control purposes, and new road building is frequently done to accommodate growing travel demand [11].

The aim of this research is to look at how well the Majalengka Ring Road is lit and how this affects drivers.

2. Literature Review

2.1 Traffic

Traffic is the vibrant movement of people and vehicles in the dynamic road traffic space. It's a beautiful blend of people, vehicles, and the road itself. Every component is essential for maintaining a harmonious flow of traffic. The mismatch between the service capacity of the infrastructure and the traffic demands in transportation, particularly in urban transportation, is further accelerated by the fast proliferation of motor vehicles [12]. Because of this interconnected link, it is crucial to maintain the organization of each component.

The most common problem in getting around is crashing. Accidents are the main common cause of traffic problems caused by an imbalance between traffic components. Similarly, the kind of vehicle, volume, traffic flow composition, highway width, etc. all have a significant impact on the rise in congestion brought on by the addition of new cars [13]. A smooth traffic system means that all its components have been fulfilled. Good street lighting is one of the road elements that is critical to the continuity of the traffic system.

In order to optimise the traffic system, there are various methods included in traffic management. By reducing the amount of disturbance and congestion, the goal of traffic management is to make traffic flow more efficient. Furthermore, traffic management is a way to achieve public health, road safety, and security. Many traffic management techniques are also intended for other objectives. For example, speed limits are sometimes set for safety or traffic control purposes, and new road building is frequently done to accommodate growing travel demand [14].

2.2 Safety of road users

Road safety is a major global concern [15]. A state of physical and emotional safety, when there is no possibility of danger, is known as safety. Being safe means that there is no chance of damage and that one is both physically and psychologically secure [16]. The goal of traffic safety is to lower these dangers, which include fatalities, collisions, and harm to both people and property.. Safety must always be considered during the road traffic process. Road accidents result in significant monetary and human losses every year, making road safety a significant concern in modern nations [17].

The most crucial element for road users is traffic signs, which naturally contribute to drivers' safety and security [18]. Traffic safety is when everyone avoids the risk of traffic accidents, which can be caused by vehicles, roads, people and the environment. According to Law No. 22 Year 2009, traffic safety includes the interaction between road users, vehicles, and road infrastructure, all of which must be effectively managed to prevent accidents. Every road user wishes to prevent traffic accidents, yet occasionally they happen unexpectedly as a result of inadequate road infrastructure or user irresponsibility [19]. Driving as a mode of transportation has major social and economic advantages, but it also carries serious hazards to one's health, such as the possibility of injury or death [20]. Therefore, traffic safety strategies should involve risk assessment and the continuous use of preventive measures to create a safer driving environment.

Road conditions affect traffic safety, with certain road conditions increasing the risk of a crash. The comparable probability of fatal accidents was five times higher for slushy road conditions [21]. For example, wet roads have a higher risk of accidents than dry roads. One factor contributing to the increased risk of accidents on roads that do not meet requirements is inadequate illumination.

2.3 Lighting

Road illumination is essential for improving road user vision at night or in low light conditions [22]. A lighting system is made up of several electrical parts that work together to give certain illumination or signage. Lighting can lower the chance of accidents by improving car and pedestrian visibility. A decrease in crime is one of the presumed advantages of road illumination on auxiliary roads [23].

Road lighting is one of the most crucial elements that drivers must have in order to improve their safety when driving at night [24]. Street lighting is an essential part of the traffic system to enable motorists and pedestrians to move safely and comfortably at night. Due to the necessity for nighttime navigation and public safety, street lighting became necessary [25]. There is evidence that the use of street lights can reduce the likelihood of accidents. This is because street lighting can increase the contrast between objects and the road surface, allowing people on the road to see objects more clearly, which increases road safety.

Road users' comfort and visual performance are significantly impacted by the quality of the lighting [26]. Traffic lighting systems must be installed properly because of their important role. When designing traffic lighting, one of the things that needs to be considered is the location that needs to be lit and the quality of the lights to be installed. The installation of traffic lights should consider the visibility of road users as well. At night, good lighting will improve accuracy and eye comfort. Because it influences the driver's capacity to react effectively to problems on the road, this is a crucial component of driving safety [27].

3. Metodology

Research, broadly speaking, refers to any activity conducted by people who have received training in gaining knowledge through systematic procedures [28]. This research uses qualitative methods with perception analysis. Qualitative methods are usually used to answer research questions that cannot be answered by quantitative methods. The data results from this study include road user perceptions of the importance of lighting to road user safety.

This study was conducted to assess the level of inadequate lighting on the Majalengka Ring Road, using the following perceived variables. The data comes from a questionnaire that was given to 40 people who use Majalengka Ring Road. The respondents were asked to rate how important and satisfied they were with the current street lighting on this road. They could choose from 1 to 5, with 1 being not important and 5 being very important or very satisfied. Importance Performance Analysis (IPA) is the method used to process the data. In an effort to satisfy customers, the firm will employ Importance Performance Analysis (IPA) to determine the critical performance elements and create a priority scale [29].
Importance Performance Analysis (IPA) usually uses the 4 quadrant method:

a. Quadrant I, Although the elements in this quadrant are very important, they are not aligned with user performance, making it difficult to apply the intended level of resources to improve performance.
b. Quadrant II, Elements in this section are very important. They work very well and meet the needs of the users. This makes sure that success continues over time.
c. Quadrant III, This quadrant's element has a low level of relevance, a performance level that isn't unduly prioritized, and relatively low expectations, which means it doesn't do much to meet the user's perceived needs.
d. Quadrant IV, This part of the university doesn't have a lot of importance, but it's doing better than it should. So, the university needs to use its resources to help other parts that need improvement [30].

The location of this research was on the Majalengka ring road. The research location is in the picture.
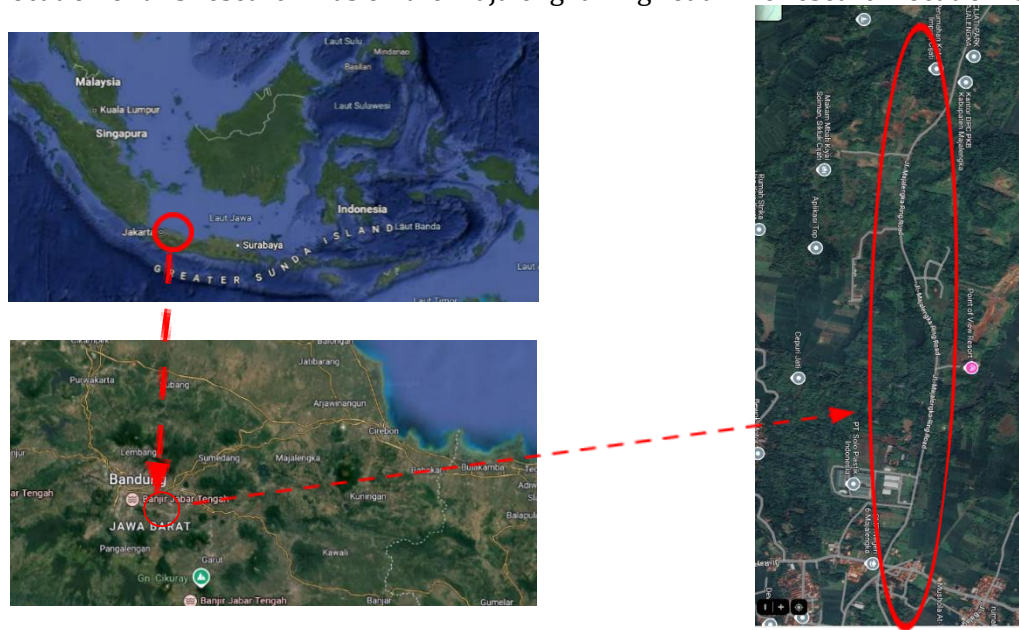
## 4. Result and Discussion

4.1 Respondent Personal Data

The data was categorized by age, gender, and vehicle used to cross the Majalengka Ring Road, and was collected from 40 respondents. According to the study data, men make up the majority of drivers on the Majalengka Ring Road. The majority of people travelling on the Majalengka Ring Road are under 20 years old, while the least frequent travellers are over 31-40 years old. Motorbikes are the most widely used means of transport at this time.

Variabel	Category	Frequency	Persent
Gender	Male	28	70%
	Female	12	30%
Age	≤20	21	53%
	21 - 30	12	30%
	31 - 40	7	18%
	41 - 50	0	0%
	51 - 60	0	0%
Vihicles Used	Car	23	58%
	Motorcycle	17	43%

4.2 The meaning and level of performance

According to the questionnaire's results, the lighting variable for cars traveling in the opposite way (4.93) was given the greatest priority value, while the lighting variable for roads with curves (1.11) earned the lowest satisfaction score. Meanwhile, lighting for activities other than transportation (4.28) received the lowest importance score.

NO	Indicator	I	P	G
A1	Lighting for safety from crime	4,45	1,13	-3,33
A2	Lighting for activities other than those related to traffic	4,28	1,30	-2,98
A3	Lighting for driving comfort	4,43	1,65	-2,78
A4	Illumination for visibility	4,35	1,69	-2,66
A5	Illumination for vehicles coming from the same direction	4,85	1,72	-3,13
A6	Illumination for vehicles coming from the opposite direction	4,93	1,20	-3,73
A7	Illumination for safe driving	4,75	1,43	-3,32
A8	Lighting for roads on curves	4,83	1,11	-3,72
A9	Lighting for roads leading to bridges	4,40	1,43	-2,97
A10	Lighting to avoid road damage	4,63	1,40	-3,23
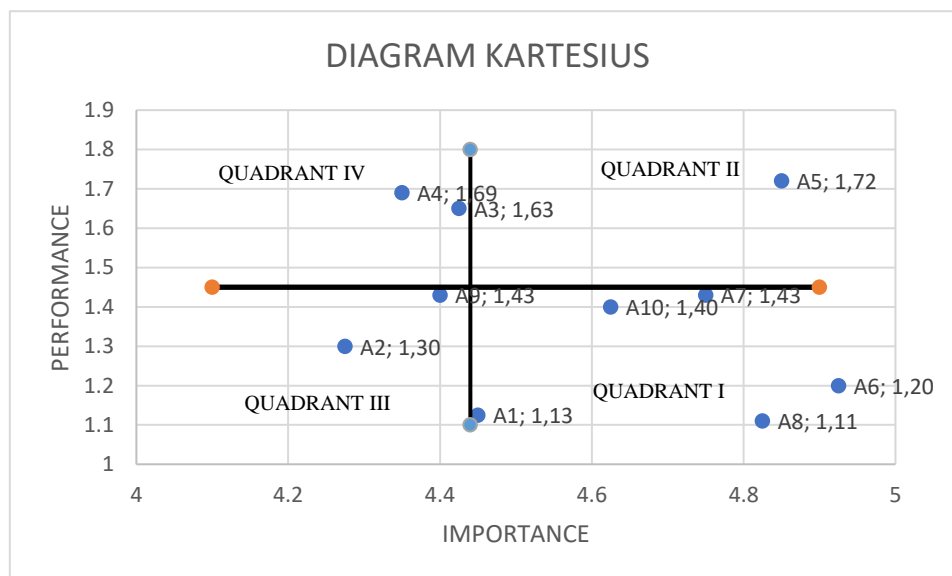
From the table above, we can see that the gap value is negative. This means that the need for lighting does not match the level of needs of road users. Variables with the greatest performance level but comparatively low relevance are found in quadrant IV of the Cartesian diagram. Quadrant III is less important and has lower performance. Quadrant II is a variable that must be maintained because of its high level of importance and performance. Section The region that requires the greatest improvement is I, the variable with the highest relevance but the lowest performance level.

After gathering data on how drivers see different components of the Majalengka Ring Road's lighting quality, 40 respondents were asked if they thought the street lighting needed to be improved. There was a five-point scale that went from strongly disagree to strongly agree. This is very important because it shows how comfortable road users are when traveling on the Majalengka Ring Road. It also helps evaluate the current lighting conditions on the road.

5. Conclusion
The results of this study show that people think street lighting is somewhat important. However, the performance of the road is only average at 1.41. There is a difference of 3.18 between the interests and satisfaction levels. The road performance that has to be enhanced to strike a balance between road

performance and road user interests is indicated by the negative number. Then, the vehicles that pass more on the ring road Majalengka are motorcycles, which as a result are more vulnerable to traffic crime. In addition, the most important factor is lighting for vehicles going in opposite directions on the road. People are most satisfied with lighting for vehicles going in the same direction. On the other hand, lighting for non-traffic-related activities was considered less important, and the lowest level of satisfaction was lighting for the road at bends.

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