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Road Spread Planning to Traffic Performance (Case Study: Roads Sukaraja, Jatiwangi, Majalengka)

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ABSTRACT

In the context of the growth of transportation infrastructure worldwide, the expansion of roads has become an important issue. Road expansion projects are often top priorities in various countries to overcome traffic congestion and improve interregional connectivity. Therefore, the role of the government in the construction of roads in Indonesia is crucial for sustainability and the need for infrastructure development and environmental protection. The purpose of the study paper entitled Road Enlargement Planning versus Traffic Performance is to investigate the effectiveness and impact of road enlargement as an infrastructure development strategy. The location of the research will be on Sukaraja Wetan Road in the Majalengka district. The quantitative method is used to observe the activity trend of Emperor Wetan. So, in this study, the survey was conducted directly at the place to be studied. The total LHR initial lifetime of the plan in 2025 with an initial traffic growth rate of 5% obtained is 1059. The amount of LHR end-life plan in 2035 with a final traffic growth figure of 7% obtaining is 1985. LEP and LEA calculations are obtained from the vehicle's distribution coefficient multiplied by the result of the initial LHR and the final LHR, then multiplied by the axis values on each vehicle. In both tables above, the LEP value is 101,746, while the LEA value is 190,6183. The LET value is 146,182, while the LER value is 148182. The CBR value is 4%, the Ground Support Force value is 4,289, and the Regional Factor is 2. The material plan to be used is the Laston Surface Layer, which is 7.5 cm, the Upper Foundation Layer (LPA) of Breakstone Class A is 20 cm, and the Lower Foundations Layer of Sirtu Class B is 40 cm.

1. Introduction

To provide community services, infrastructure development is a component of national development (Sahara, Rifai, & Irianto, 2022). Modern cities rely on transportation networks to maintain their socioeconomic viability and environmental sustainability (Ali, Shah, & Hussain, 2020). In the context of the growth of transportation infrastructure worldwide, the expansion of roads has become an important issue. While urbanization rapidly increases human population growth, it also pressures production to meet demands (Ayobami & Dokumo, 2020). metropolitan road networks are heavily congested due to the fast increase in the metropolitan population (Anupriya, Bansal, & Graham, 2023). Road expansion projects are often top priorities in various countries to overcome traffic jams and improve interregional connectivity. However, it is not uncommon for road-breaking projects to raise debates about environmental issues, land liberation, and social impact. Therefore, international cooperation and knowledge exchange are essential to address the problem and ensure that road development projects contribute to sustainable development world wide.

Managing growing cities is critical and complex (Shi, et al., 2019). Often, the expansion of roads in the Asian region has become a controversial topic that sparked a debate about infrastructure needs and its environmental impact. Road infrastructure development is often presented as a development catalyst in developing countries (Sisay, 2024). Some people believe that the expansion of the road is crucial to supporting rapid economic growth in the region. They say that a wider road will increase mobility, accelerate the distribution of goods, and encourage investment in areas related to the industry. However, the impact of the road expansion projects has caused many people to worry about deforestation, wildlife habitat damage, and higher air pollution. Therefore, the construction of highways in the Asian region has become a complex issue that requires a careful approach to balancing environmental conservation and economic development.

The issue of road extension in Indonesia is a complex problem that often raises pros and cons in society. Development is a continuous process to improve people's welfare (Nugraha, Prayitno, Situmorang, & Nasution, 2020). Roads in good condition will smooth traffic (Syaiful & Rusfana, 2022). Some people argue that to overcome the increasing traffic jams in big cities like Jakarta, Surabaya, and Bandung, it is necessary to expand roads. Some people who support the construction of new roads argue that it will increase mobility and accelerate economic progress in the region. However, the expansion of roads has many opponents because of its negative environmental impact. Besides, there are also concerns that residential settlements or agricultural lands that must be sacrificed for such infrastructure projects will be destroyed. Therefore, the role of the government in the construction of roads in Indonesia is crucial for sustainability and the need for infrastructure development and environmental protection.

Nowadays, over half of the world's population resides in cities due to benefits and possibilities, including access to better services and employment (Rustiadi, et al., 2021). Traditional highway planning and design frequently call for more conservative measures to overcome notable elevation inequalities in order to increase traffic safety, such as extending lane lengths and road widths (Salsabila, Rifai, & Taufik, 2022). The spread of roads on Sukaraja Wetan, Jatiwangi, and Majalengka roads is controversial among locals. Some inhabitants support the expansion of roads because it is believed to improve accessibility and streamline transportation, especially for large vehicles such as farm trucks. However, there are also opponents of the project because of concerns that it will hurt the environment and the lives of local communities. They are worried about the loss of farmland or family funerals that might have to be sacrificed for the road expansion project. In addition, some citizens also feel that they need to be sufficiently involved in the decision-making process related to the project, resulting in dissatisfaction and tension among them.

The purpose of the study paper entitled Road Enlargement Planning versus Traffic Performance is to investigate the effectiveness and impact of road enlargement as an infrastructure development strategy. This paper analyses the road expansion projects implemented at various locations, focusing on mobility, economics, and the environment. Through a comprehensive collection of data and information, the authors attempted to evaluate the success of the road expansion project in achieving the set goals. In addition, the paper also aims to present findings that can serve as a basis for future policy and strategy improvements related to road construction. Thus, the writing of this paper is expected to provide better insight for policymakers, practitioners, and academics in understanding the implications of road-breaking on society and the environment.

2. Literature Review

2.1 Traffic Performance

The main objective of the road is to provide safe, balanced, and long-lasting road performance (Farid, Rifai, & Taufik, 2020). Traffic performance is the effectiveness of road systems in regulating the movement of vehicles and people. People need to be able to move around the neighborhood effectively and safely (Zlatkovic, Zlatkovic, Sullivan, Bjornstad, & Shahandashti, 2019). Some of the main indicators of traffic performance are the vehicle's average speed, the volume of vehicles crossing, and the level of congestion. Due to population density and growth, there is a problem with traffic congestion, which causes very slow vehicle movement (Andika, Rifai, Isradi, & Prasetijo, 2022). Low levels of congestion indicate good traffic management and adequate road infrastructure. When a traffic incident happens, the traffic authorities' plan for providing traffic direction heavily depends on accurate and timely incident duration prediction (Tang, Zheng, Han, Liu, & Cai, 2020). The number of vehicles that can handle without causing congestion also indicates adequate road capacity. All these indicators are vital to assess how well the road system helps daily mobility.

Urban road supply and demand are becoming more and more out of balance, and as the number of vehicles owned increases quickly, traffic congestion is becoming a bigger issue (Zhang, Zha, Zhang, & Ma, 2023). Among the factors influencing traffic performance are traffic management, driver behaviour, and road design. Good road design, including sufficient columns and supporting facilities such as traffic alarms, are essential. Effective traffic administration and following traffic rules and light signals are also important. Driver behaviour, such as obeying the rules and becoming aware while driving, is also important. For optimal traffic performance, these three components must work together. Improving overall performance with just one improvement element and good collaboration is possible.

The Indonesian transportation system has a significant impact on the effective and efficient support of transportation infrastructure and amenities, in addition to technological advancements (Hafram & Asrib, 2022). To improve traffic performance, a comprehensive and sustainable approach is needed. One of the most important factors in promoting community activities in metropolitan areas is the accessibility of transportation amenities and infrastructure (Rifai, Thalib, Prayogo, & Isradi, 2022). More and more people using public transport can reduce the highway burden. To raise driver awareness, it is also important to conduct road safety education and campaigns. Infrastructure improvements and traffic policies must be evaluated and adjusted periodically. These measures are expected to continue to improve traffic performance and promote safe and efficient mobility.

2.2 Road Spread

The majority of today's emissions and the historical rise are caused by transportation by roads (Mattioli, Roberts, Steinberger, & Brown, 2020). Because it increases air pollution, vehicle noise, and the amount of time that both private and public vehicles need to travel, traffic is regarded as a global issue (Wincent, Rifai, & Isradi, 2022). The road expansion is carried out with the primary purpose of reducing congestion and facilitating traffic flows. Usually, this process is done on roads with many vehicles and often experiences severe congestion. In an effort to shorten travel times and manage traffic congestion, several communities have increased the amount of space and infrastructure allocated to automobiles (Karimi, Ghadirifaraz, & Shetab Boushehri, 2022). Travel time and efficiency are expected to be reduced with larger parking spaces. However, expanding the road also requires comprehensive preparation to avoid creating new problems, such as relocation of utilities or interference with the surrounding environment. Road expansion also often takes a lot of money and time.

Transportation problems are a severe problem; developing countries are also experiencing them (Firmansyah, Rifai, & Taufik, 2022). One of the efforts to tackle the problem is by extending roads. Road expansion also has a positive impact on driving safety. Carriageway lanes are added to motorways to boost capacity due to traffic congestion and future traffic growth predictions (Metz, 2021). With extra space, the rider has more room for manoeuvre and reduces the risk of accidents, but this must be offset by strict surveillance so as not to be too quick. In addition, the expansion of the road should be followed by improved support facilities such as traffic lanes and adequate street lighting.

The enhancement of community facilities and infrastructure is one way that regional development can be a reflection of the health of the local economy (Rifai, Surgiarti, Isradi, & Mufhidin, 2021). From an economic perspective, the construction of highways can improve the efficiency and productivity of the distribution of goods and services. Systems of efficient, sustainable infrastructure are essential to a country's economic stability and efficient transportation (Luo, and Sandanayake, and Zhang, & and Tan, 2021). With smoother traffic flows, delivery times can be accelerated and vehicle operating costs reduced. Evaluating traffic performance after deployment is also important to ensure that the targets of increasing capacity and traffic smoothness are achieved. Therefore, expanding the road can provide the greatest economic and social benefits.

2.3 Traffic Management

A systematic effort to regulate the flow of vehicles and pedestrians to ensure smoothness and safety on the highways is known as traffic management. Strict traffic rules and consistent law enforcement are essential to avoid violations and accidents. Planning and building adequate road infrastructure is also necessary for good traffic management. It is evident that there is a need for more intelligent solutions that make use of cutting-edge technologies to implement a smart traffic management system given the sharp rise in the number of vehicles and the impossibility to expand the width and number of roads in many cities (Elsagheer Mohamed & AlShalfan, 2021). All these efforts aim to create a safe and efficient traffic environment for all those who use the road.

The population growth has led to an increase in the demand for automobiles, which has raised the need for transportation (Rabby, Islam, & Imon, 2019). Traffic management needs to raise public awareness of the importance of driving safety. In addition, traffic management must consider special needs, such as accessibility for pedestrians and persons with disabilities. Data for analysis and decision-making can be accessed through traffic sensors and surveillance cameras. By tracking traffic patterns and modifying traffic signal timing, an intelligent transportation system can enhance traffic flow in smart cities (Saleem, et al., 2022). To ensure effective traffic management, relevant agencies such as traffic police, liaison services, and local governments must work together. Traffic control can succeed with a holistic approach and the active participation of all parties.

A major contributing aspect to conservation planning and development in the southern world is the growth of the highway system (Ulchurriyyah, Rifai, & Taufik, 2022). Effective traffic management requires improved infrastructure and reliable public transport systems. Organized and integrated parking systems are also crucial to reducing congestion in the city centre. Certain parking facilities make use of the space on the road, but only on those that are specifically chosen by the local government according to parking control zoning (Rahayu, Rifai, & Akhir, 2022). A key component of effective traffic management is ongoing monitoring and assessment to determine how successfully plans and regulations have been put into practice and how well they have improved people's quality of life by facilitating efficient, safe, and comfortable transportation. Therefore, proper traffic management requires an effective strategic management plan (Almazrouei, and Yassin, & and Memon, 2021).

3. Methodology

3.1 *Type of Research*

This study employed a quantitative approach. By gathering quantifiable, unchanging, precise data and analyzing it with mathematical techniques, quantitative research explains phenomena. In particular, statistics that answer the questions who, what, when, where, how much, how many, and how (Mohajan, 2020). The premise of quantitative research is that the constructs being studied are measurable (Kotronoulas, et al., 2023). The quantitative method is used to observe Sukaraja Wetan's activity trend. So, in this study, the survey was conducted directly at the place to be studied.

3.2 *Research Location*

The research location to be carried out is Sukaraja Wetan Road in the Majalengka district.

Figure 1. Research Location

3.3 *Data Collection*

Primary and secondary data entry is the method of data collection employed in the study. To collect traffic statistics, primary data is taken straight out of the survey and transmitted into the field. Location maps are utilized to analyze Sukaraja Wetan Road; from these maps, secondary information is obtained.

This data includes the number of vehicles, the coating layer's lifetime and plan thickness, and the design of the crossing calculations' outcome.

4. Result and Discussion

4.1 Thick planning of road clogging

In planning a thick layer of clamping on road construction, there is a need for supporting data. The data used for the thick planning of the road clamp is.

Road classification = Class II

Road width = 6 meters

Direction = 1 column 2 directions

Plan age = 10 years

Average annual rainfall = 1800 mm/year

Road smoothness = 6%

Initial vehicle growth = 5%

Final vehicle development = 7%

1) Traffic Data

Table 1. Daily Traffic Data

VEHICLE TYPE	LHR
Motorcycle, Wheeled Vehicle 3	694
Sedan, Jeep	112
Opelet (Pickup Combi)	80
Pickup, Pickup Box	98
Small Bus	6
Big Bus	0
Two-Axis Light Truck	12
The Truck is on Two Axes	5
Truk As 3	2
Number of Vehicle	1009

Source: Research Results

4.2 Average Daily Traffic Early Age Plan and End Age Plan

1) Initial LHR Determination

LHR in 2025 (early plan life) with traffic growth of 5%, then LHR early plan life with initial plan life value = 1 year.

Motorcycle, Wheeled Vehicle 3	694	(1 + 0,05)^1	=	729
Sedan, Jeep	112	(1 + 0,05)^1	=	118
Opelet (Pickup Combi)	80	(1 + 0,05)^1	=	84
Pickup, Pickup Box	98	(1 + 0,05)^1	=	103
Small Bus	6	(1 + 0,05)^1	=	6
Big Bus	0	(1 + 0,05)^1	=	0
Two-Axis Light Truck	12	(1 + 0,05)^1	=	13
The Truck is on Two Axes	5	(1 + 0,05)^1	=	5

truk as 3	2	(1 + 0,05)^1	=	2
Number of LHR 2025				1059

The initial LHR is planned for 2025 with a 5% traffic growth rate of 1059.

2) Final LHR determination

LHR in 2035 (end of plan life) with traffic growth of 7%, then end of plan lifespan with plan end life value = 10 years.

Motorcycle, Wheeled Vehicle 3	694	(1 + 0,07)^10	=	1365
Sedan, Jeep	112	(1 + 0,07)^10	=	220
Opelet (Pickup Combi)	80	(1 + 0,07)^10	=	157
Pickup, Pickup Box	98	(1 + 0,07)^10	=	193
Small Bus	6	(1 + 0,07)^10	=	12
Big Bus	0	(1 + 0,07)^10	=	0
Two-Axis Light Truck	12	(1 + 0,07)^10	=	24
The Truck is on Two Axes	5	(1 + 0,07)^10	=	10
truk as 3	2	(1 + 0,07)^10	=	4
Number of LHR 2035				1985

The total LHR ends the plan's lifetime in 2035, with the final traffic growth rate of 7% achieved in 1985.

4.3 Determining Equivalent Numbers

Table 2. Equivalent numbers

Vehicle Type	Axis	Axis	Equivalent
Motorcycle, Wheeled Vehicle 3	(1)	0.0002	0.0002
Sedan, Jeep	(1 + 1)	0.0002 + 0.0002	0.0004
Opelet (Pickup Combi)	(2 + 3)	0.0036 + 0.0183	0.0219
Pickup, Pickup Box	(5 + 8)	0.0143 + 0.9238	0.9426
Small Bus	(3 + 6)	0.0198 + 0.0251	0.0449
Big Bus	(3 + 7)	0.0016 + 0.0466	0.0428
Two-Axis Light Truck	(3 + 5)	0.0016 + 0.1753	0.1769
The Truck is on Two Axes	(6 + 12)	0.0293 + 0.0002	0.0295
truk as 3	(6 + 19)	0.0251 + 0.0002	0.0253

Source: Calculation Results

The equivalent figure for each vehicle is obtained from a comparison of the level of damage caused by the axle load path on the vehicle. It can be seen in Table 2 that the axle values obtained for each vehicle are different, whereas the equivalent numbers produced are also different.

1) Calculating LEP (Initial Equivalent Cross) and LEA (Final Equivalent Cross)

Table 3. Initial Equivalent Cross Value

Motorcycle, Wheeled Vehicle 3	=	1	x	729	x	0,0002	=	0,14574
Sedan, Jeep	=	1	x	118	x	0,0004	=	0,04704
Opelet (Pickup Combi)	=	1	x	84	x	0,0219	=	1,8396
Pickup, Pickup Box	=	1	x	103	x	0,9426	=	96,99354
Small Bus	=	1	x	6	x	0,0449	=	0,28287
Big Bus	=	1	x	0	x	0,0428	=	0
Two-Axis Light Truck	=	1	x	13	x	0,1769	=	2,22894
The Truck is on Two Axes	=	1	x	5	x	0,0295	=	0,154875

Truk As 3	=	1	x	2	x	0,0253	=	0,05313
Number of LEP							=	101,746

Source: Calculation Results

Table 4. Cross-end equivalence values

Motorcycle, Wheeled Vehicle 3	=	1	x	1365	x	0,0002	=	0,273041
Sedan, Jeep	=	1	x	220	x	0,0004	=	0,088128
Opelet (Pickup Combi)	=	1	x	157	x	0,0219	=	3,446449
Pickup, Pickup Box	=	1	x	193	x	0,9426	=	181,7152
Small Bus	=	1	x	12	x	0,0449	=	0,529951
Big Bus	=	1	x	0	x	0,0428	=	0
Two-Axis Light Truck	=	1	x	24	x	0,1769	=	4,175869
The Truck is on Two Axes	=	1	x	10	x	0,0295	=	0,290155
Truk As 3	=	1	x	4	x	0,0253	=	0,099538
Number of LEA								190,6183

Source: Calculation Results

In Tables 3 and 4, the LEP and LEA calculations are produced from the vehicle distribution coefficient multiplied by the initial LHR and final LHR results, then multiplied by the axle value for each vehicle. It can be seen in the two tables above that the LEP value obtained is 101.746, while the LEA value obtained is 190.6183.

2) Calculating LET (Central Equivalent Cross) and LER (Planned Equivalent Cross)

	=	1/2	x	LEP	+	LEA
LET	=	1/2	x	101,746	+	190,6183
	=			146,182		

	=	LET	x	UR	:	10
LER	=	146,182	x	10	:	10
	=		146,182			

The LET calculation is calculated by multiplying half the LEP value and then adding the LEA value. Meanwhile, LER is produced from the LET value multiplied by UR (plan age) and then divided by 10 because the planned life is 10 years, where the LET value obtained was 146.182, while the LER value obtained was 148.182.

4.4 CBR (California Bearing Ratio) Pricing Determination

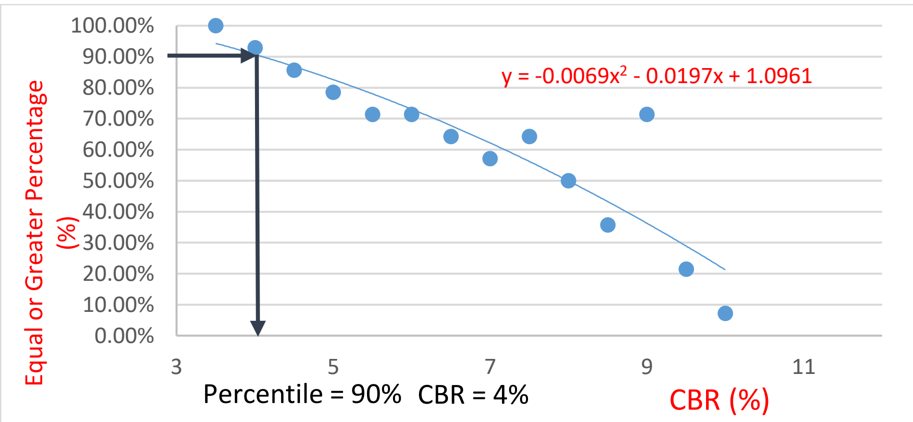

Figure 2. CBR Value Determination Diagram

The diagram above shows that the CBR values entered range from 3.5 to 10. Where each CBR value increases by 0.5. The above diagram above shows the CBR value obtained, which is 4%.

4.5 Determination of Pavement Thickness Index

CBR value = 4

DDT value = 4.3 x Log 4 + 1,7

= 4.289

IP0 = ≥ 4

Ipt = 2

FR = 2

LER = 146.182

4.6 Determination of Relative Strength Coefficient

Determining the relative strength coefficient (a) of each type of pavement layer selected is 0.40. The material plan will use the Laston Surface Layer; the top foundation layer uses Class A crushed stone, and the bottom foundation layer uses Class B sirtu.

ITP = a1 x D1 + a2 x D2 + a3 x D3

10,5 = (0,4 x 7,5) + (0,14 x 20) + (0,12 x D3)

10,5 = 5,8 + (0,12 x D3)

D3 = 39,16 ≈ 40 cm.

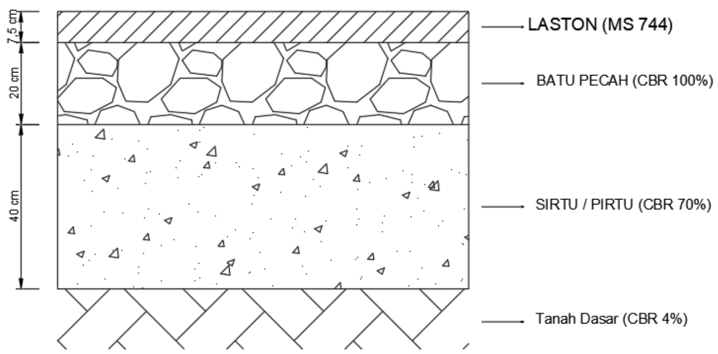

Figure 3. Intersection of the calculation results

5. Conclusion

Values are used to plan for road pavement thickness that can satisfy the needs of the road and LHR that matches the intended age. The CBR value obtained is 4%, the Soil Carrying Capacity is 4,289, and the Regional Factor is 2. For a 10-year pavement thickness plan with an initial planned vehicle growth value of 5%, the LHR is 1059 vehicles. Meanwhile, in 2035, with a vehicle growth value of 7%, the LHR will be 1985 vehicles. Based on the road pavement thickness planning instructions using the Bina Marga method, the planned materials to be used are 7.5 cm for the Laston Surface Layer, 20 cm for the Class A Crushed Stone Upper Foundation Layer (LPA), and 20 cm for the Sirtu Lower Foundation Layer (LPB). Class B 40 cm.

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