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Road Performance Analysis in Maliana District, Bobonaro Regency, Timor Leste

Domingos Godinho [1] , Hanie Teki Tjendani [2] , Esti Wulandari [3]
Universitas 17 Agustus 1945 Surabaya, Indonesia
* Email: domingosgodinho511@gmail.com, hanie@untag-sby.ac.id, wulandariesti@untag-sby.ac.id

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ABSTRACT

Transportation is an important part that cannot be separated from human life, as it plays a crucial role in various aspects, including socio-cultural, economic, engineering, political, defense, and legal sectors. Roads are one of the primary means of transportation that significantly impact the development and progress of a region by facilitating the movement of goods, services, and people. The purpose of this study is to determine the performance of the Maliana - Bobonaro road transportation section, which serves as a vital route connecting key areas and supporting local economic growth. This study utilizes the Calculation Capacity Road method based on the PKJI 2023 (Indonesian Road Capacity Guidelines) to assess road performance and travel time. The results of the study indicate that the Maliana – Bobonaro road section demonstrates good performance, with a capacity (C) of 2735.85 smp/hour, a degree of saturation of 0.235 and 0.195, and a level of service categorized as A and B. These results suggest that the road operates efficiently with minimal congestion, ensuring smooth traffic flow and reducing travel time. However, continuous monitoring and periodic evaluations are essential to maintain this performance level, especially with potential future increases in traffic volume due to regional development. This study provides valuable insights for policymakers and transportation planners in improving road infrastructure and ensuring sustainable transportation systems.

INTRODUCTION

Roads are land transportation infrastructure that includes all parts of the road, including complementary buildings and equipment intended for traffic, which are on the surface of the ground, above the surface of the ground, below the surface of the ground/or water, except for railroads, lorry roads, and cable roads. Roads are a very important factor for residents to connect between one area and another, in addition, roads also function to facilitate economic activities and daily activities of residents. Economic development and increasing levels of prosperity of the population will result in an increase in the level of travel. Traffic occurs due to the need for transportation from the community, where people are always looking for faster, safer and smoother roads. The increase in population and the large number of urbanization of urban vehicles will cause a level of movement and density, so that the need for transportation will also increase. Traffic congestion is something that is no longer foreign to us in big cities, especially the developing city of Bobonaro. This condition can be seen on the road section in Maliana District where traffic conditions on the road are dense and irregular, especially during rush hour and not infrequently on this route there is congestion that can affect the safety and delays of road users.

Transportation is an important part that cannot be separated from human life today. Transportation plays a role in various aspects of socio-culture, economy, engineering, politics, defense and law. The development of transportation is very important in supporting and driving development because it functions as a catalyst in supporting economic growth and development of a region such as the State of Timor Leste based on history has gone through three colonial colonizations starting from the Portuguese colonizing for approximately 450 years, Japan colonizing for approximately 2.5 years and Indonesia for 24 years from time to time road construction in Timor Leste has received less attention, but now the government is trying to build connectivity between one city and another, especially cities located on the border between the State of Timor Leste and the State of Indonesia, including the city of Bobonara Regency and the city of Covalima Regency.

After gaining independence, so much development has led to traffic congestion on urban roads in big cities becoming a common problem, especially in developing countries such as Timor Leste in general and Bobonaro Regency in particular. One of the factors causing the increasingly severe congestion problem is the increasing number of vehicle ownership, while the available road width is unable to accommodate the number of vehicles that are increasing every day. Bobonaro Regency, which is one of the densely populated regencies which has many crowded places such as markets and interesting tourist attractions, will indirectly result in an increase

in the number of vehicles on the connecting roads to these crowded areas. Maliana-Bobonaro Road in Bobonaro Regency, which serves important flows from various directions, namely from and to the Market, as well as flows from and to Bobonaro Regency and flows from and to Dili City, is 3 km long, with 4 lanes and 2 directions with this median is one of the arterial roads that are often used by road users. With the large volume of vehicles crossing this road, it has a direct impact on the resulting congestion. In relation to this, the author tries to examine the performance of the Maliana-Bobonaro road section, especially at the intersection of Balibo District to the Bobonaro intersection which often experiences congestion. And calculate the operational costs of vehicles due to the delay. Therefore, based on the description above, I am interested in studying it more deeply and pouring it into a scientific paper, in the form of a final assignment entitled "Analysis of Road Section Performance in Maliana District in Bobonaro Regency, Timor Leste". The increasing number of vehicle movements in an area will indirectly result in various traffic problems that need to be handled continuously. These problems arise because of the continuous increase in the number of vehicles in an area while the available road capacity does not change. This will result in an increase in the generation and attraction at a certain point and time.

The road in Maliana District is a main road located in the middle of Maliana City and close to the border between the city of Atambua Indonesia to tourism such as hot spring tourism in Bobonaro District and in this area there are several Hotel buildings, Shops, Boarding houses in Maliana City so that many vehicles pass, exit / enter, and park on the road, as well as many human activities around the road. The research method used in data collection is direct observation and recording in the field. For primary data includes: road geometric data, traffic volume data and traffic speed. While secondary data includes literature studies and the Indonesian Road Capacity Guidelines (Afni et al., 2023). As a basis for completing the data used are traffic volume, Side obstacles, road capacity, Degree of saturation, Free flow speed and speed and travel time contained in the Indonesian Road Capacity P (Afni et al., 2023). Congestion is increasing and the number of vehicles and transportation needs are increasing while the provision of planned facilities no longer meets existing needs. So the previously planned infrastructure function has not fully functioned well and optimally, and the transportation infrastructure needs of city residents are disrupted. In addition to the increasingly limited provision of transportation infrastructure, there are many other causes of traffic congestion.

There are several experts defining traffic flow, but the basic measurements that are often used are flow concentration and speed. Flow and volume are often considered the same, although the term flow is more appropriate to express traffic flow and contains the meaning of the number of vehicles contained in a space measured in a certain time interval. Traffic flow is formed from the movement of individual drivers and vehicles that interact with each other on a road section and its environment. Because the perception and ability of individual drivers have different characteristics, the behavior of vehicles in traffic flow cannot be standardized, furthermore traffic flow will experience differences in characteristics due to driver behavior and driving habits. Traffic flow on a road section will vary in characteristics both based on location and time. According to Silvia (Lewis & Sukirman, 1994), the size or dimensions of the road affect the traffic flow passing over it. Although traffic lanes are made the same width, the traffic flow will not be the same because the environment is different. In rural areas, interference from the side is not as great as in urban areas, so the speed in urban areas is lower than in rural areas. The condition of the road surface and the geometric properties of the road alignment also affect traffic flow. Thus, traffic flow is closely related to the land use patterns around it. The definite impact that will arise due to the increase in transportation modes is traffic congestion , Where congestion is Wrong One form consequence height amount man on a the area that The same on time And the same path . This has consequences in the form of increasingly complicated traffic conflicts. This conflict can be seen from the traffic that occurs everyday on a road section, human needs that require transportation, concentration of various types of vehicles in one place and so on. Good road conditions certainly have an impact on the travel time of vehicles crossing the road section.

Transportation infrastructure plays a significant role in fostering regional development, especially in emerging economies. High-quality road networks are vital for ensuring efficient movement of people and goods, facilitating trade, and supporting socio-economic growth (Banister & Berechman, 2003). In developing countries like Timor Leste, the availability of well-maintained roads is a cornerstone of regional integration and economic sustainability. Studies show that poor road conditions often lead to higher vehicle operating costs, reduced road safety, and longer travel times, directly affecting local economies (Stromquist, 2019).

The importance of road infrastructure in border regions is particularly notable, as these areas often serve as gateways for trade and cultural exchange (Rodrigue, 2020). In Timor Leste, roads like the Maliana-Bobonaro route not only connect urban centers but also serve as strategic corridors facilitating cross-border trade with Indonesia. However, the growth of vehicle ownership and inadequate infrastructure upgrades have led to traffic inefficiencies and congestion, impeding economic progress (Booth, 2021).

Rural-urban connectivity is a critical aspect of transportation planning. Roads that link remote areas to major economic hubs play a crucial role in reducing poverty and enhancing access to education, healthcare, and markets (Fan & Chan-Kang, 2005). In the context of Timor Leste, improving road performance in districts like Maliana is essential for fostering regional equity and development. Research by (Ali & Pernia, 2003)emphasizes that investments in rural road infrastructure yield significant socio-economic benefits, including increased agricultural productivity and local business growth.

However, maintaining efficient road performance requires continuous evaluation of road capacity, traffic flow, and vehicle operating costs. Traditional road assessment methods, such as the Indonesian Road Capacity Guidelines (PKJI), provide a standardized framework for evaluating these parameters (Afni et al., 2023). While PKJI has been widely adopted in Indonesia, its application in Timor Leste remains limited, highlighting the need for localized studies that account for regional traffic characteristics and socio-economic contexts (Herwiyanti et al., 2017)Environmental factors also play a pivotal role in road performance. Studies indicate that factors such as rainfall intensity, soil stability, and temperature fluctuations significantly affect pavement durability and traffic safety (Akbarian et al., 2019). In tropical regions like Timor Leste, heavy rainfall often leads to road erosion and surface degradation, resulting in increased maintenance costs and reduced road lifespan (Reza et al., 2023)). Understanding these environmental impacts is crucial for developing sustainable transportation strategies in the region.

Traffic congestion, a growing concern in many developing regions, is often attributed to the mismatch between vehicle volume and road capacity (Litman, 2014). In Bobonaro Regency, the increasing number of private vehicles, coupled with limited road expansions, has exacerbated congestion issues, particularly along key arterial roads like Maliana-Bobonaro. Congestion not only affects travel time but also contributes to environmental pollution and fuel wastage, further burdening local economies (Downs, 2005).

Another critical factor affecting road performance is side friction—interference from roadside activities such as parking, market stalls, and pedestrian crossings. Research by (Arya et al., 2020) highlights that unmanaged side friction significantly reduces road capacity and increases the likelihood of traffic conflicts. In Maliana District, the presence of markets, hotels, and tourism spots along the road corridor adds to traffic complexity, underscoring the need for comprehensive traffic management strategies.

Technological advancements offer new opportunities for improving road performance analysis. The integration of Geographic Information Systems (GIS) and remote sensing technologies has enabled more accurate traffic data collection and real-time monitoring of road conditions (Liang et al., 2024). Utilizing these tools can help local authorities in Timor Leste develop data-driven policies and optimize infrastructure planning, ultimately improving road efficiency and safety.

Policy interventions are equally important in addressing road performance issues. Effective transportation policies should not only focus on infrastructure development but also incorporate strategies for traffic management, environmental conservation, and community engagement (Gwilliam, 2003). In Timor Leste, collaborative efforts between government agencies, local communities, and international organizations are essential for fostering sustainable transportation systems.

In conclusion, enhancing the performance of the Maliana-Bobonaro road section requires a multifaceted approach that integrates technical, environmental, and socio-economic considerations. This study aims to contribute to the growing body of research on rural-urban road connectivity in developing countries and provide actionable insights for policymakers and transportation planners in Timor Leste. The road section connecting Balibo - Bobonaro sub-districts is a parallel border road section with a length of approximately 156.231 km with an effective length of handling in 2018/2019 of 8.2 km. The condition of the road section is not yet stable so that it affects the travel time of vehicles crossing the road section. With the condition of the road section, many vehicles need hours to be able to cross the road section.

Several studies have explored road performance analysis to optimize transportation systems and address traffic congestion issues. Research by Silvia (Lewis & Sukirman, 1994) emphasized that road dimensions significantly impact traffic flow, with urban roads typically experiencing slower speeds due to side friction compared to rural roads. Other studies have also used the PKJI method to evaluate road capacities and levels of service in various regions, confirming its reliability in identifying bottlenecks and assessing road efficiency. However, most of these studies focused primarily on urban traffic congestion without deeply investigating the impacts on rural arterial roads that link strategic economic hubs.

While previous studies have effectively addressed urban traffic congestion using PKJI methodologies, limited research has examined the performance of inter-district roads like the Maliana-Bobonaro route in Timor Leste. This study fills the gap by analyzing a key rural-urban connecting road that serves as a major transportation artery between Bobonaro and Dili City. Furthermore, few studies have explored how pavement conditions and vehicle operating costs influence road efficiency in regions with increasing traffic demands, leaving a critical gap in understanding infrastructure sustainability in developing countries.

The novelty of this research lies in its comprehensive evaluation of the Maliana-Bobonaro road section using the PKJI 2023 method while incorporating an analysis of vehicle operating costs and road pavement conditions factors often overlooked in previous studies. By calculating the degree of accompaniment and travel time delays, the study highlights hidden inefficiencies despite the road's high service level. This dual approach provides a holistic understanding of road performance beyond simple capacity and saturation analyses, offering new insights into transportation planning in border regions.

This research offers practical and academic benefits. For policymakers and transportation planners, it provides valuable data-driven insights for improving road infrastructure, minimizing traffic delays, and reducing vehicle operating costs. The findings can inform future policy decisions and infrastructure investments aimed at

enhancing connectivity and economic growth in border areas. Academically, the study contributes to the existing body of knowledge on rural transportation systems, serving as a reference for future research on road performance analysis in developing countries.

The purpose of this study is to analyze the performance of road sections in Maliana District, Bobonaro Regency. The benefits of this study include the development of analytical skills, scientific writing skills, and practical experience of students in research methodology; improving academic reputation, accreditation, and contributions to the development of science for institutions; and providing practical solutions, data for policy making, program evaluation, and references for further research for related stakeholders.

METHOD

This research method includes collecting primary data through direct observation at the research location to identify technical, environmental, and land conditions, as well as secondary data obtained from literature, articles, and related agencies. Data were collected through interviews with contractors, consultants, and related agencies; systematic field observations; and literature studies from various literature sources. Data analysis was carried out using the PKJI 2023 method to calculate road section performance and travel time.

RESULTS AND DISCUSSION

Performance Section Road Maliana-Bobonaro

In calculation performance section road Maliana-Bobonaro which includes calculation capacity road, degree boredom , time travel And degrees accompaniment use help form ir-3 (Afni et al., 2023) as following :

Figure 1. IR-3 Form for Calculating Road Section Performance

JALAN PERKOTAAN	Tanggal	Nov-Des 2024	Ditandatangani oleh	Ir. Wahyu Hartianto	
FORMULIR IR-3 : ANALISA	No. Ruas				
KECEPATAN, KAPASITAS	Kode Segmen		Tipe Daerah	Perkotaan	
IRINGAN	Periode Waktu	Puncak		Kondisi tidak ada median	

Kecepatan arus bebas kendaraan ringan — FV = (FV0+FVw) X FFVsf X FFVcs

Soal/Arah	Kecepatan arus faktor penyesuaian Bebas Dasar untuk lebar jalur		Fvo+FVw			Kecepatan Arus Bebas
	Fvo Tabel 2.6 (km/jam)	FVw Tabel 2.7 km/jam	(2) + (3) km/jam	Hambatan samping FFVsf Tabel 2.8 atau 2.8	Ukuran kota FFVcs Tabel 2.10	FV (4) x (5) x (6) (km/jam)
1	2	3	4	5	6	7
Arah 1	44	1,5	45,5	0,99	0,93	41,89
Arah 2	44	1,5	45,5	0,99	0,93	41,89

Kapasitas — C = Co x FCw x FCsp x FCsf x FCcs

Soal/Arah	Kapasitas Dasar Co Tabel 2.11 (smp/jam)	Faktor Penyesuaian untuk Kapasitas				Kapasitas Cz
		Lebar jalur FCw Tabel 2.12	Pemisah Arah FCsp Tabel 2.13	Hambatan Samping FCsf Tabel 2.14 atau 2.15	Ukuran Kota FCcs Tabel 2.16	smp/jam (11) x (12) x (13) x (14) x (15)
10	11	12	13	14	15	16
Arah 1	2900	1,07	1,00	0,98	0,9	2736,85
Arah 2	2900	1,07	1,00	0,98	0,9	2736,85

Kecepatan kendaraan Gabungan

Soal/Arah	Arus Lalu kintas (Q) Formulir UR-2 (smp/jam)	Derajat Kejenuhan DS (21)/(16)	Kecepatan VLV Gbr 2.7 atau 2.8 (km/jam)	Panjang Segmen jln L (km)	Waktu Tempuh TT (24)/(25) (jam)
20	21	22	23	24	25
Arah 1	647,00	0,236	42,00	6,9	0,164
Arah 2	525,50	0,192	45,00	6,9	0,153

Hanya untuk 2/2 UD : Derajat iringan
Arah 1 (Dari grafik derajat iringan) 0,49
Arah 2 (Dari grafik derajat iringan) 0,44

Source: Calculation Results, 2024

From the calculation results, the value of the Maliana-Bobonaro Road Performance is as follows:

1. **Calculation of Free Flow Speed of Light Vehicles**

   FV = **(FV_0 + FV_w) x FV_{SF} x FFV_{CS}**

   FV_0 = 44 Km/Hour

   FV_w = 1.5

   FV_{SF} = 0.99

   FFV_{CS} = 0.93

   So the FV value = 41.89 Km/hour

2. **Calculation Capacity Road**

   C = **C_0 x FC_{QW} FC_{SP} x FC_{SF} x FC_{CS} (pcu /hour)**

   C_0 = From table 2.11 the value is = 2.900

   FC_{QW} = From table 2.12 the value is obtained = 1.07

   FC_{SP} = From table 2.13 the value is = 1.00

   FC_{SF} = From table 2.14 the value is = 0.98

   FC_{Cs} = From table 2.16, the value is = 0.90

   So that Value C = 2736.85 smp /hour

3. Calculation Degrees Saturation (DS)

DS = Q/C

For DS Direction value Maliana-Bobonaro = 647/2736.85 = 0.236

For DS direction value Bobonaro-Maliana =525.5/2736.85 = 0.196

4. Calculation of Service Level (*level of service*)

Q/C value

For DS Direction value Maliana-Bobonaro = 647/2736.85 = 0.236 = B

For DS direction value Bobonaro-Maliana =525.5/2736.85 = 0.196 = A

Table . 1 Results Analysis *level of service* Road Maliana-Bobonaro

Level of Service	Characteristics	V/C
A	Free flow conditions with high speed and low traffic volume. Drivers can choose desired speed without obstacle	0.00-0.19
B	In a stable flow zone. Drivers have the freedom to choose their speed.	

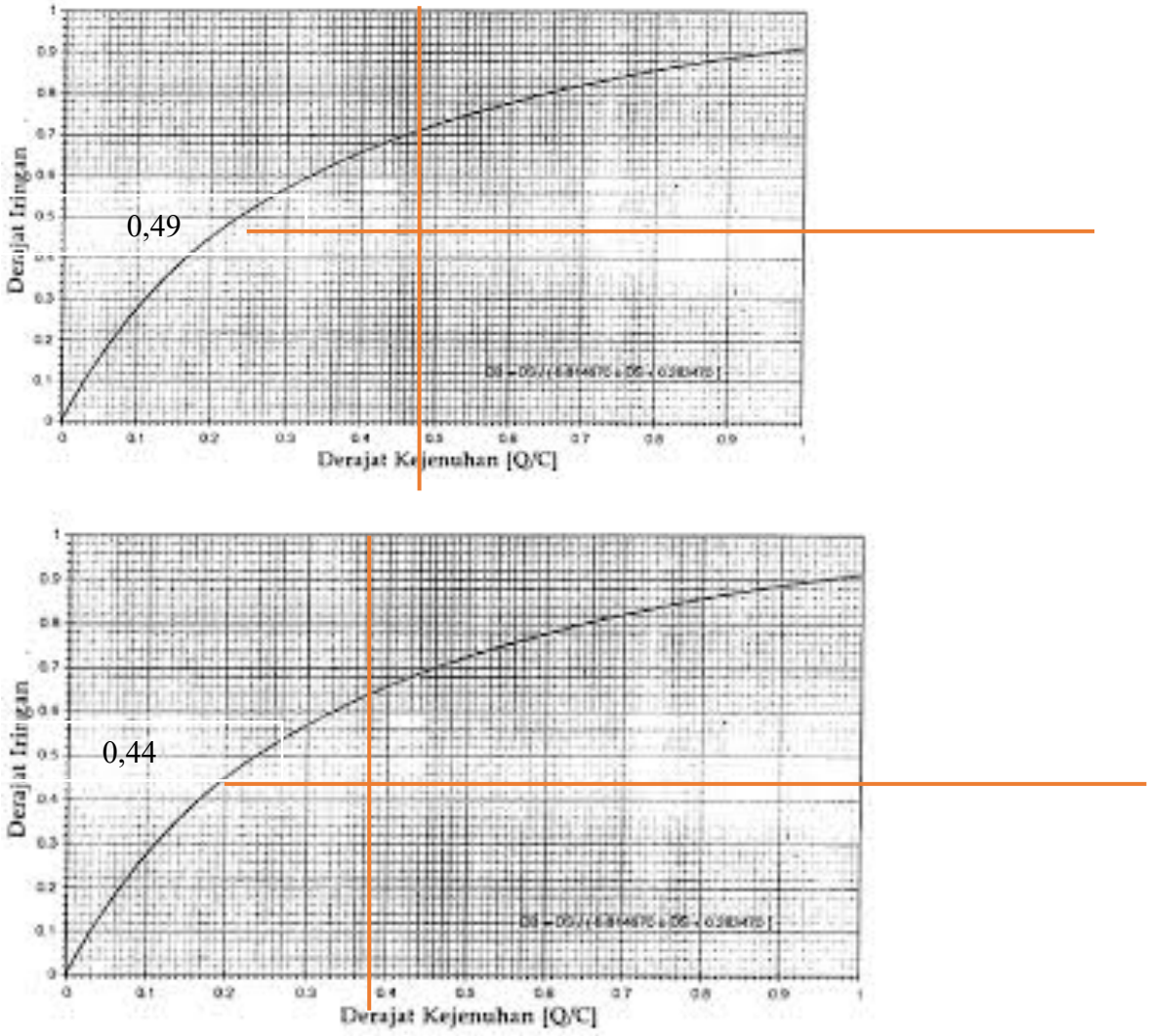
Source : Indonesian Road Capacity Guidelines , 2023

The condition of the Maliana-Bobonaro Road Section actually has a good level of road service, namely category A to B, which means there is no congestion on the road flow. However, the fundamental problem is the condition of the road pavement which is experiencing obstacles, causing travel time to be long, which causes vehicle operating costs to increase.

5. Calculation Degrees Accompaniment

Based on the calculation results on form-3 and based on the calculation graph, the values obtained for the degree of accompaniment for the Maliana-Bobonaro road section are as follows:

Figure 2 . Calculation of the Convoy for the Maliana-Bobonaro Road Section



Degree of Accompaniment of Maliana-Bobonaro Road Section = 0.49 (Table IR-3)

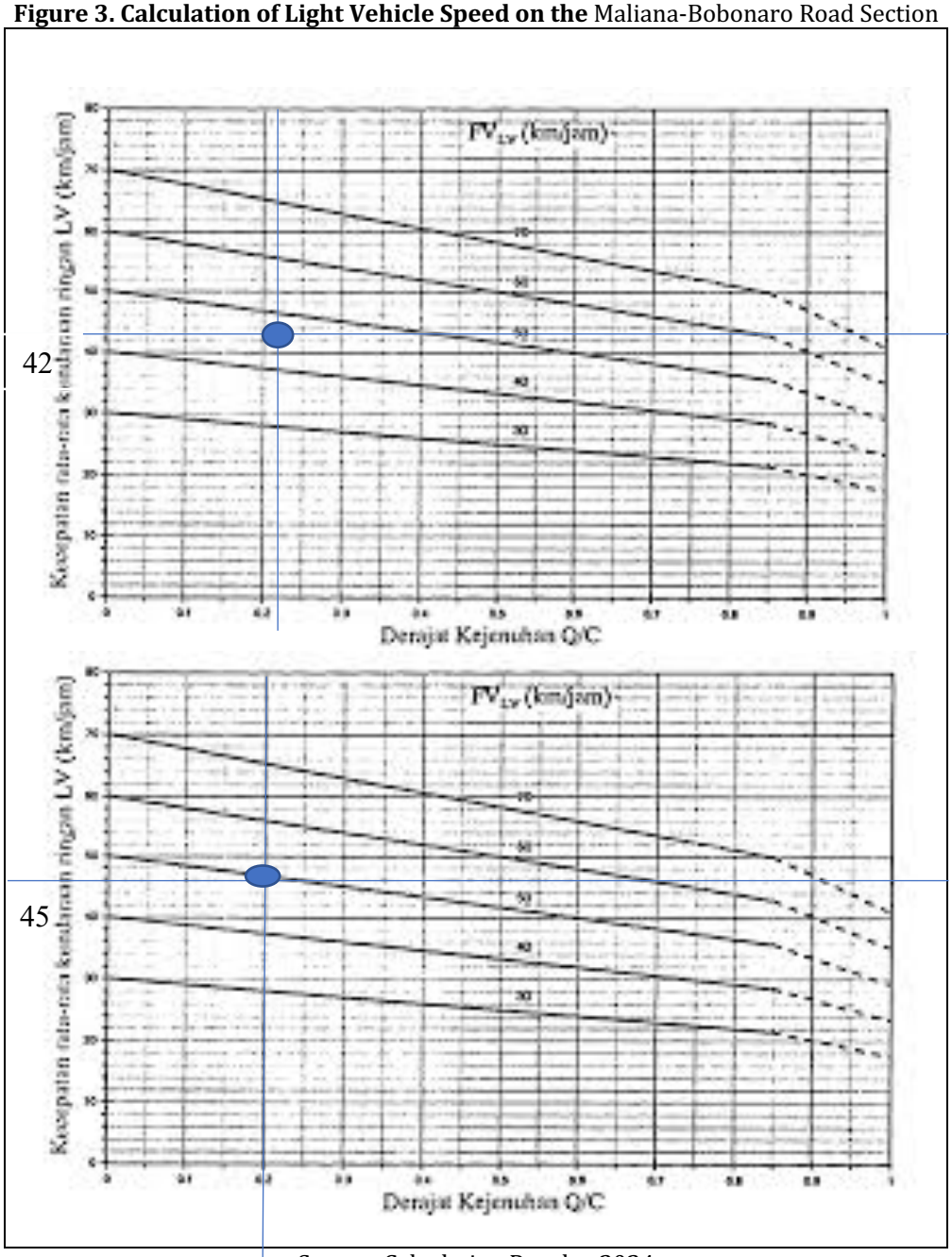
Degree of Accompaniment of Bobonaro-Maliana Road Section = 0.44 (Table IR-3)

Travel Time Calculation

Travel Time Calculation Planned Trip

The manual uses travel time speed as the primary measure of road segment performance, because it is easy to understand and measure and is the most important input to road usage costs in economic analysis. Travel speed is defined in the manual as the average speed of light vehicle (LV) space along the road:
Based on the calculation results on Form IR-3, the travel time value is as follows:

Figure 3. Calculation of Light Vehicle Speed on the Maliana-Bobonaro Road Section



Source: Calculation Results, 2024

Design Vehicle Speed Direction 1 (V1) = 42 Km/Hour
Design Vehicle Speed Direction 2 (V2) = 45 Km/Hour
Segment Length (L) = 6.9 Km
So: TT1= 6.9:42 = 0.146
TT2=6.9:45 = 0.153

Existing Travel Time Calculation

The journey from Maliana to Bobonaro with existing conditions before the road was repaired was as follows:

The length of the Maliana-Bobonaro road = 6.9 Km
Travel time is = 2 hours
So: Travel speed is = 6.9/2
= 3.45 Km/Hour

CONCLUSION

The results of the analysis and calculations show that the construction of the Maliana-Bobonaro road section shows transportation performance with decent or good performance, indicated by the free flow speed value (FV = 41.89 km/hour), road capacity (C = 2736.85 smp/hour), degree of saturation (DS ≤ 0.236), level of service (LOS = AB), and degree of accompaniment (0.44–0.49).

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