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Evaluation Of Road Performance On Freight Route Shifting Towards The Dumai And Selinsing Industrial Areas

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Abstract

The development of the Dumai and Selinsing industrial areas has led to an increase in freight traffic, impacting the performance of roads serving logistics distribution activities. The high volume of heavy vehicles on Jalan Arifin Ahmad has the potential to reduce the level of road service, necessitating an evaluation of the planned rerouting of freight transport to Jalan Abdul Naim as an alternative route. The research methods used were traffic surveys, vehicle speed surveys, road geometric data collection, and road performance analysis based on the 2023 Indonesian Road Capacity Guidelines (PKJI). The parameters analyzed included traffic volume, road capacity, degree of saturation (DJ), free flow speed, travel time, and level of service (Level of Service/LOS). The analysis was conducted on existing conditions, after the rerouting, and projected traffic growth for the 5- and 10-year periods. The research results show that under existing conditions, Jalan Arifin Ahmad has a capacity of 2,318 SMP/hour, a traffic volume of 679 SMP/hour, and a saturation level of 0.29 with a service level of B. After heavy vehicles were transferred to the alternative route, traffic volume decreased to 637 SMP/hour with a saturation level of 0.27, remaining at LOS B. In the 5th year projection, the saturation level increased to 0.53 (LOS C) and in the 10th year to 0.64 (LOS C). Meanwhile, Jalan Abdul Naim, as an alternative route, demonstrated excellent performance with a saturation level ranging from 0.16–0.24 and a service level of A–B. The research results indicate that the rerouting of freight transport can reduce traffic load on Jalan Arifin Ahmad without reducing the performance of Jalan Abdul Naim, making this alternative route suitable for supporting smooth distribution to the Dumai and Selinsing industrial areas.

Keywords: ***Road Performance, Route Changes, Freight Transport, Degree Of Saturation, Level Of Road Service, Industrial Areas***

INTRODUCTION

The development of industrial areas is one of the main drivers of regional economic growth. The existence of industrial areas in Dumai and Selinsing has increased logistics distribution activities, particularly freight transportation that relies on road networks as the primary infrastructure. (Hendrialdi, 2018; Erwan et al., 2010; Sirait et al., 2023). The increasing movement of heavy vehicles to and from these industrial areas has placed significant pressure on the performance of existing road segments, both in terms of capacity, speed, and traffic service levels (Hendrialdi, 2018; Erwan et al., 2010).

The road segments used by freight vehicles are generally also utilized by general traffic, resulting in conflicts between heavy vehicles and light vehicles. This condition is often exacerbated by limited road geometry, high side friction, and road classifications that are not fully designed to accommodate high volumes and intensive loads of heavy vehicles. Consequently, during certain periods, vehicle speeds decrease, delays increase, and the Level of Service (LOS) declines, leading to reduced user comfort and decreased efficiency of the transportation system (Erwan et al., 2010; Hendrialdi, 2018).

Route shifting is influenced not only by road performance conditions but also by other factors, such as traffic management policies, restrictions on heavy vehicle operations, and considerations of travel time and cost efficiency. However, freight route shifting may create new problems on alternative road segments, including increased traffic volumes, reduced service levels, and potential pavement damage if the capacity and structural conditions of the roads are inadequate. Therefore, a road performance evaluation study is required to analyze the conditions of existing and alternative road

segments used by freight vehicles heading to the Dumai and Selinsing industrial areas (Hendrialdi, 2018; Ramadani & Sari, 2023).

This evaluation includes the analysis of traffic volume, road capacity, Level of Service (LOS), and vehicle speed before and after freight route shifting occurs. The results of this study are expected to provide a comprehensive overview of the impact of freight route shifting on traffic performance (Dina et al., 2022; Saputra et al., 2023).

One strategy that can be implemented to reduce traffic loads on certain road segments is the relocation or diversion of freight vehicle routes to alternative roads. The implementation of alternative routes can serve as a traffic management and engineering strategy to reduce the volume-to-capacity ratio on road segments experiencing high traffic loads (Saputra et al., 2023). However, redirecting heavy vehicle flows to alternative routes must consider the capacity and road conditions to prevent new transportation problems within the road network (Erwan et al., 2010; Dina et al., 2022). Therefore, alternative route selection should be based on a comprehensive road performance evaluation.

In the context of Dumai City, freight vehicle route performance evaluations have also been conducted using road capacity analysis and transportation modeling approaches. Previous studies indicate that, generally, several road segments are still capable of accommodating existing traffic volumes; however, certain segments require special attention regarding their Level of Service and overall road network performance (Wahyuni & Idham, 2022).

RESEARCH METHODS

This study conducted Average Daily Traffic (ADT) surveys and road geometric surveys. Traffic data were analyzed using the 2023 Indonesian Road Capacity Guidelines (PKJI 2023) to obtain the degree of saturation (DJ) and Level of Service (LOS). Furthermore, the traffic conditions were simulated using PTV VISSIM software.

Research Location

The study location is situated on Jalan Arifin Ahmad, Dumai City, which consists of two road sections, as shown in Figure 1. Data collection was carried out for forty hours, divided into ten hours per day. The survey was conducted by two surveyors, with one surveyor assigned to each road section.

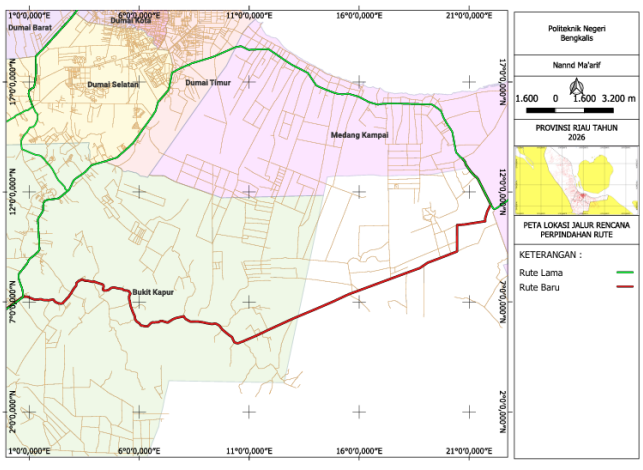

Figure 1. Research Location

Field Data Collection Stage

To assist the surveyors during field activities, the data collection stages were systematically designed. Through structured procedures, the research process became more efficient, and the collected data were more accurate and reliable.

Average Daily Traffic (ADT) Survey

The Average Daily Traffic (ADT) survey was conducted for a total duration of 40 hours. The survey started from 07:00–12:00 Western Indonesian Time (WIB) and continued from 13:00–17:00

WIB. Data collection was carried out over four days, with a duration of 10 hours per day and recorded at 15-minute intervals.

Road Geometric Survey

Road geometric data were collected through direct field observations. The collected data included road width and shoulder width, which were used as parameters in evaluating road performance.

Modeling Method

In this study, traffic modeling was performed using PTV VISSIM Student Version 6 software. The VISSIM simulation model was applied to predict and analyze future traffic conditions. Through this modeling approach, potential traffic problems can be identified, and effective strategies can be developed to overcome congestion issues. Therefore, the simulation results can support better infrastructure planning and improve traffic efficiency in the future.

RESULTS AND DISCUSSION

Road Performance Analysis Results

This study presents an analysis of road performance using PTV VISSIM software and the 2023 Indonesian Road Capacity Guidelines (PKJI 2023).

Road Performance Evaluation

Road Capacity

The following equation was used to calculate road capacity:

$C = CO \times FCLJ \times FCPA \times FCHS \times FCUK$

For urban roads, namely Jalan Arifin Ahmad before route shifting, with parameters of CO = 2800, FCLJ = 1, FCPA = 1, FCHS = 0.92, and FCUK = 0.90, the obtained road capacity was 2318 pcu/hour. Meanwhile, Jalan Arifin Ahmad after route shifting, with the same parameters (CO = 2800, FCLJ = 1, FCPA = 1, FCHS = 0.92, and FCUK = 0.90), also resulted in a capacity of 2318 pcu/hour. For the alternative route outside the urban area, namely Jalan Abdul Naim, with parameters of CO = 2800, FCLJ = 1, FCPA = 1, FCHS = 1.01, and FCUK = 0.90, the calculated road capacity was 2545 pcu/hour.

Traffic Volume

The highest traffic volume on Jalan Arifin Ahmad occurred on a specific observation day. Based on traffic calculations, the highest volume was recorded on Wednesday, reaching 679 passenger car units per hour (pcu/hour). Meanwhile, the analyzed route after shifting recorded a traffic volume of 637 pcu/hour on Wednesday. The alternative route on Jalan Abdul Naim recorded a traffic volume of 404 pcu/hour on the same day.

Free Flow Speed

The free-flow speed was calculated using the equation:

$VD.MP = ((VBD) + (FVBHS)) \times (FCBUK)$

For Jalan Arifin Ahmad, the free-flow speed was obtained as:

$VD.MP = ((42) + (0.96)) \times (0.93) = 37$ km/hour

Meanwhile, for Jalan Abdul Naim (alternative route), the calculation was:

$VB.MP = ((42) + (1.01)) \times (0.93) = 39$ km/hour

Road Segment Performance

Based on the analysis of Jalan Arifin Ahmad and the alternative route on Jalan Abdul Naim in the Dumai–Selinsing industrial area, the Level of Service (LOS) was determined as presented in Table 1.

The analysis showed that Jalan Arifin Ahmad before route shifting had a degree of saturation (DJ) value of 0.29. After freight route shifting, the DJ value decreased to 0.27. Meanwhile, the alternative route on Jalan Abdul Naim had a lower DJ value of 0.16.

These results indicate significant differences in traffic saturation levels between the two routes. The lower saturation level on the alternative route indicates that Jalan Abdul Naim still has sufficient capacity to accommodate existing traffic volumes. In contrast, the higher saturation level on Jalan Arifin Ahmad indicates the potential need for capacity improvement or more effective traffic management strategies.

Table 1. Existing Road Performance

Road Segment	Day	Road Capacity (pcu/hour)	Traffic Flow (pcu/hour)	Degree of Saturation	LOS
Arifin Ahmad Before Route Shifting	1	2318	679	0.29	B
Arifin Ahmad After Route Shifting	1	2318	637	0.27	B
Abdul Naim	1	2545	404	0.16	A

Free Flow Speed

Table 2. Free Flow Speed

No.	Road Segment	Free Flow Speed (km/hour)
1	Arifin Ahmad	37
2	Abdul Naim	39

Road Performance Under Planned Conditions

Road Performance Under Planned Conditions Without Scenario

The objective of freight transportation management in this study is to improve the performance of Jalan Arifin Ahmad, where traffic volume is predicted to increase significantly over the planning period.

Future road performance forecasting is required to evaluate traffic management and engineering strategies. The prediction was conducted using a traffic growth rate calculated from traffic conditions in 2019 and 2023, resulting in a growth rate of 4.71%.

Forecasting was conducted for a period of five and ten years. Through freight route diversion to Jalan Abdul Naim, traffic loads on Jalan Arifin Ahmad are expected to decrease, improving road performance based on future traffic growth predictions.

Table 3. Road Performance for 5-Year Projection

Road Segment	Day	Capacity (pcu/hour)	Traffic Flow (pcu/hour)	Degree of Saturation
Arifin Ahmad	1	2318	1227	0.53

Table 4. Road Performance for 10-Year Projection

Road Segment	Day	Capacity (pcu/hour)	Traffic Flow (pcu/hour)	Degree of Saturation
Arifin Ahmad	1	2421	1545	0.64

Road Performance Under Freight Route Shifting Scenario

The proposed traffic management strategy involves diverting freight vehicle movements from Jalan Arifin Ahmad to Jalan Abdul Naim.

The analysis results show that after route shifting, the performance of Jalan Arifin Ahmad improved. This improvement was indicated by a decrease in the degree of saturation from 0.29 before route shifting to 0.27 after route shifting, while the alternative route recorded a DJ value of 0.16 under existing conditions.

Table 5. Existing Condition After Freight Route Shifting

Road Segment	Day	Capacity (pcu/hour)	Traffic Flow (pcu/hour)	Degree of Saturation
Arifin Ahmad	1	2318	637	0.27

Table 6. Freight Route Shifting Scenario (5 Years)

Road Segment	Day	Capacity (pcu/hour)	Traffic Flow (pcu/hour)	Degree of Saturation
Arifin Ahmad	1	2318	1190	0.51

Table 7. Freight Route Shifting Scenario (10 Years)

Road Segment	Day	Capacity (pcu/hour)	Traffic Flow (pcu/hour)	Degree of Saturation
Arifin Ahmad	1	2421	1497	0.62

Level of Service (LOS)

After evaluating the performance of Jalan Arifin Ahmad and Jalan Abdul Naim, the Level of Service (LOS) was determined based on the degree of saturation (DJ). The DJ value represents traffic density on a road segment. A higher DJ value indicates heavier traffic conditions and a lower LOS.

According to PKJI 2023, road performance is classified into six LOS categories, ranging from A to F, based on different DJ values.

LOS Classification Results

Tabel 8. Level Of Service

Jalan Arifin Ahmad Before Route Shifting

Condition	DJ	LOS
Existing	0.29	B
5 Years Future Condition	0.53	C
10 Years Future Condition	0.64	C

Jalan Arifin Ahmad After Route Shifting

Condition	DJ	LOS
Existing	0.27	B
5 Years Future Condition	0.51	C
10 Years Future Condition	0.62	C

Jalan Abdul Naim Alternative Route

Condition	DJ	LOS
Existing	0.16	A
5 Years Future Condition	0.20	A
10 Years Future Condition	0.24	B

Comparison of Degree of Saturation (DS) and Level of Service (LOS) on Arifin Ahmad Road Before Route Diversion

The characteristics of traffic flow on Arifin Ahmad Road changed after the implementation of the goods transportation route diversion. The comparison of the Degree of Saturation (DS) and Level of Service (LOS) values before and after the route diversion is presented as follows:

Table 9. Capacity and Performance of Arifin Ahmad Road

No.	Day	Road Capacity (C)	Traffic Flow (Q) (pcu/hour)	Degree of Saturation (DS)	Traffic Condition (Congested/Not Congested)	LOS
1	Wednesday	2318	679	0.29	Not Congested	B
2	Thursday	2318	975	0.42	Not Congested	B
3	Saturday	2318	953	0.41	Not Congested	B
4	Sunday	2318	896	0.39	Not Congested	B

Note: DS = Degree of Saturation; LOS = Level of Service; pcu/hour = passenger car unit per hour.

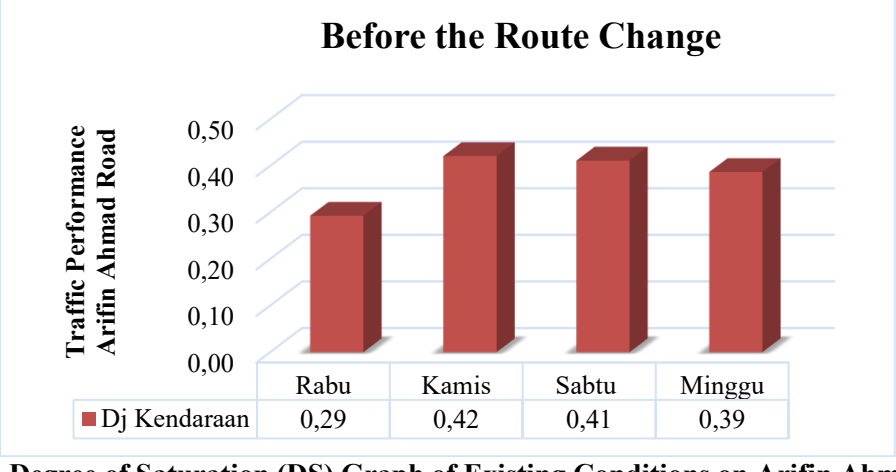

Figure 3. Degree of Saturation (DS) Graph of Existing Conditions on Arifin Ahmad Road

Table 10. Capacity and Performance of Arifin Ahmad Road After Route Diversion

No.	Day	Road Capacity (C)	Traffic Flow (Q) (pcu/hour)	Degree of Saturation (DS)	Traffic Condition (Congested/Not Congested)	LOS
1	Wednesday	2318	637	0.27	Not Congested	B
2	Thursday	2318	945	0.41	Not Congested	B
3	Saturday	2318	915	0.39	Not Congested	B
4	Sunday	2318	861	0.37	Not Congested	B

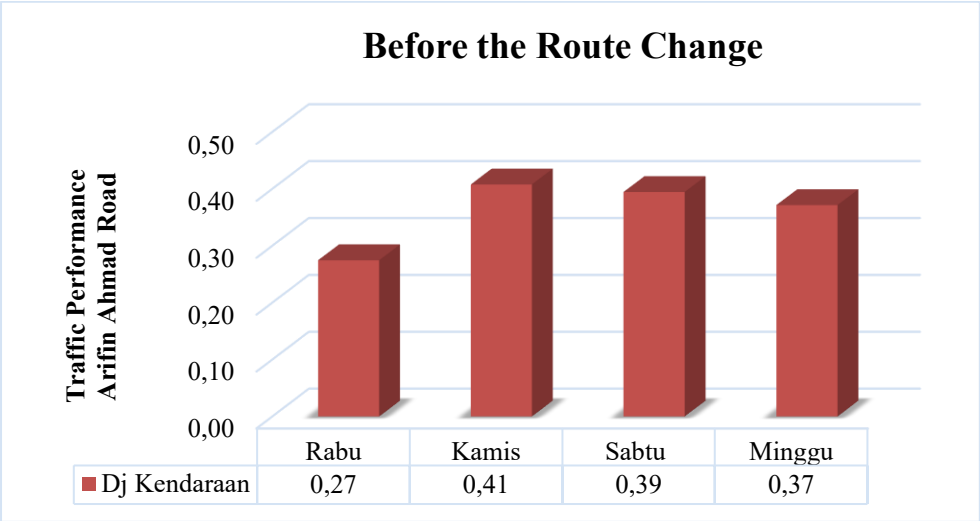

Figure 4. Degree of Saturation (DS) Graph of Arifin Ahmad Road After Route Diversion

Table 11. Capacity and Performance of Abdul Naim Road as an Alternative Route

No.	Day	Road Capacity (C)	Traffic Flow (Q) (pcu/hour)	Degree of Saturation (DS)	Traffic Condition (Congested/Not Congested)	LOS
1	Wednesday	2545	404	0.16	Not Congested	A
2	Thursday	2545	368	0.14	Not Congested	A
3	Saturday	2545	382	0.15	Not Congested	A
4	Sunday	2545	370	0.15	Not Congested	A

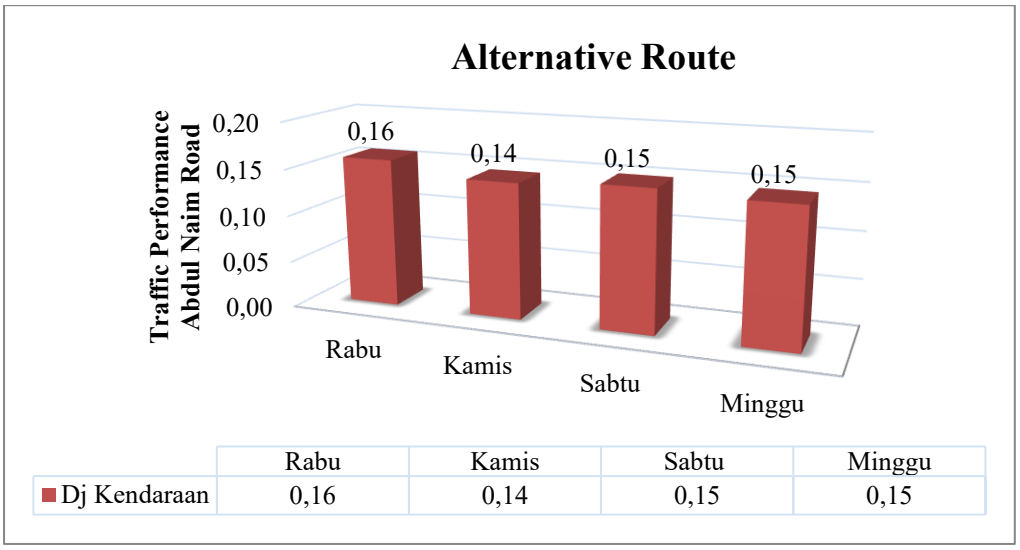

Figure 5. Degree of Saturation (DS) Graph of Abdul Naim Road as an Alternative Route

Table 12. Comparison of Degree of Saturation (DS) and Level of Service (LOS) Values

Road Section	Day	Road Capacity (C)	Traffic Flow (Q) (pcu/hour)	Degree of Saturation (DS)	LOS
Arifin Ahmad Road Before Route Diversion	1	2318	679	0.29	B
	2	2318	975	0.42	B
	3	2318	953	0.41	B
	4	2318	896	0.39	B

Comparison Before and After Goods Transportation Route Diversion

Road Section	Day	Road Capacity (C)	Traffic Flow (Q) (pcu/hour)	Degree of Saturation (DS)	LOS
Arifin Ahmad Road After Route Diversion	1	2318	637	0.27	B
	2	2318	945	0.41	B
	3	2318	915	0.39	B
	4	2318	861	0.37	B

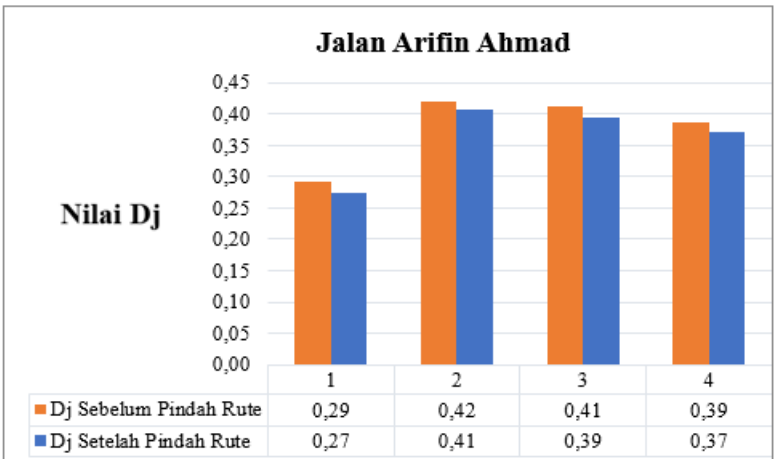

Figure 6. Comparison Graph of Degree of Saturation (DS) and Level of Service (LOS)

Traffic Modeling

The VISSIM software was used to model the road network with the output representing road segment performance. The simulation included both the projected future conditions and the planned scenario involving goods transportation route diversion.

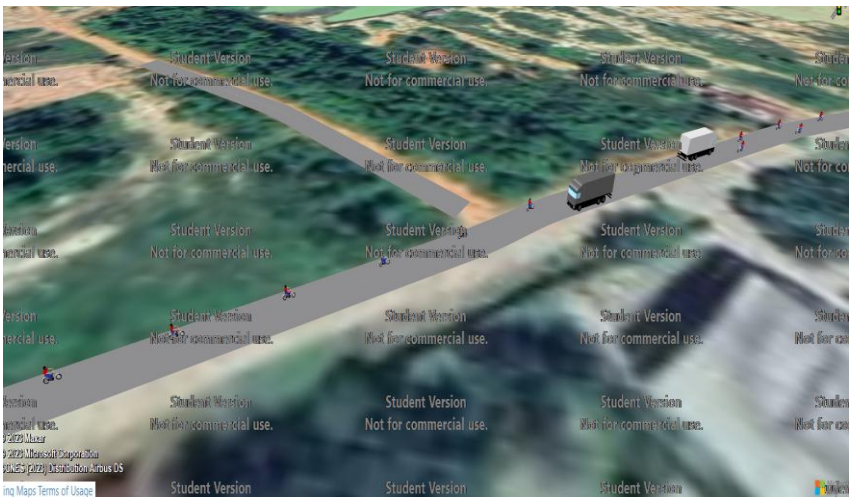

Figure 7. Route Diversion Simulation Model

CONCLUSION

Under existing conditions, Jalan Arifin Ahmad on Wednesday has a road capacity of 2,318 pcu/hour with a traffic flow of 679 pcu/hour and a degree of saturation (DS) of 0.29, which is categorized as Level of Service (LOS) B. After heavy vehicles were diverted, the traffic flow decreased to 637 pcu/hour with a degree of saturation of 0.27, while the LOS remained B.

In the 5-year projection period, traffic flow increased to 1,227 pcu/hour with a degree of saturation of 0.53, which is categorized as LOS C. After the diversion of heavy vehicles, the traffic flow decreased to 1,190 pcu/hour with a degree of saturation of 0.51, while the LOS remained C.

In the 10-year projection period, traffic flow increased significantly to 1,545 pcu/hour with a degree of saturation of 0.64, and the LOS remained C, indicating that traffic conditions were approaching congestion. After heavy vehicles were diverted, the traffic flow decreased to 1,497 pcu/hour with a degree of saturation of 0.62, with the LOS remaining C.

The alternative route on Jalan Abdul Naim showed a very low degree of saturation, with traffic flow ranging from 404 pcu/hour to 640 pcu/hour and a degree of saturation between 0.16 and 0.24. The LOS ranged from A to B, depending on the route diversion scenario and the projection period (5 or 10 years). These results indicate that Jalan Abdul Naim still has sufficient capacity to accommodate diverted freight traffic and can serve as an alternative route to reduce the traffic burden on Jalan Arifin Ahmad.

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