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Assesment of Intersection Capacity at Persiaran Pulai Perdana

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Abstract

This study analyzes the operational performance of the four intersections along Jalan Persiaran Pulai Perdana in Johor during peak hours in 2023. Researchers meticulously measure traffic volume in both morning and evening peak periods, using SIDRA version 8 for data analysis. The current 4-leg intersection exhibits movement issues in most lanes, leading to inefficiency and congestion, with researchers studying Level of Service (LOS) F for potential improvements. To optimize future traffic flow, enhancing capacity and LOS for most lanes is crucial, prioritizing strategic enhancements for congestion relief. Adopting these strategies ensures a more streamlined and effective transportation system, promising a convenient travel experience. If a flyover replaces the current four-way intersection, LOS could improve from F to a more favorable A or B grade. This planning initiative is driven by time constraints, emphasizing the urgent need to address road challenges. The project aims to benefit Majlis Bandaraya Iskandar Puteri (MBIP) by enhancing traffic management along Jalan Persiaran Pulai Perdana, leading to a more efficient and safer transportation system.

1. Introduction

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Rapid urbanization has transformed municipalities into hubs of economic activity, cultural exchange, and vibrant social interaction. However, this swift urban expansion has brought about significant challenges, with traffic congestion emerging as a major concern. The roots of urban traffic congestion lie in a complex interplay of historical, social, economic, and infrastructural factors. The population growth, economic opportunities, and allure of city life have fuelled an increased demand for mobility, overwhelming the existing road networks. The prevalence of private vehicle ownership, driven by the automobile industry and a cultural shift, exacerbates the issue. This research focuses on studying traffic flow on Persiaran Pulai Perdana during peak hours, collecting data on volumes, speeds, and route patterns. The analysis will concentrate on current traffic conditions, identifying patterns, congestion hotspots, and flow dynamics.

The alarming rise in traffic congestion in urban areas across the globe is putting a strain on urban areas' efficiency, sustainability, and quality of life in general. Commuters are becoming increasingly frustrated and anxious due to the pervasive traffic congestion on the Persiaran Pulai Perdana during weekday rush hours, which is preventing vehicles from smoothly flowing and poses possible safety issues. High vehicle density and limited road capacity are two of the causes of this congestion, and this study will explore both. Our goal is to ascertain the level of service (LOS) on the main road by analysing intersection delays and traffic volume counts.

This study on Jalan Persiaran Pulai Perdana in Johor Bahru aims to achieve two specific objectives: comprehensively examining traffic volume patterns and variations during specified periods and assessing the

operational efficiency of signalized intersections. The focus is on gaining insights into overall vehicular activity, congestion levels, and usage. To accomplish this, the SIDRA analysis is employed as a valuable tool, enabling experts and urban planners to model and test different traffic flow scenarios. This aids in optimizing intersections and proposing targeted solutions, contributing to informed decisions on infrastructure improvements and policy interventions for more efficient and livable cities. Addressing traffic congestion requires a holistic understanding, thoughtful planning, and strategic interventions to establish sustainable, accessible, and efficient urban transportation systems, as emphasized in prior research (Taylor et al., 2017; Sinha & Labi, 2011; Bibri & Krogstie, 2017; Ceder, 2021).

2. Material and Methods

The study, focusing on traffic congestion in Johor City from Skudai to Pontian, employed the empirical gap acceptance approach with SIDRA software for operational performance analysis (Theofilatos & Yannis, 2014). The research methodology, explained in this chapter, encompasses subject area description, data collection methods, and analytical approaches for capacity, delay, queue length, and loss of signal over time (LOS) during peak hours.

Before data collection, a survey identified the Persiaran Pulai Perdana intersection, known for congestion. Site exploration included map analysis and on-site visits. This intersection, vital for Pulai and Pontian residents heading to Skudai and Johor Bahru, was chosen due to its congestion during peak hours.

Data collection encompassed geometric characteristics, traffic volume, and approach lane wait times during peak hours. Video recordings conducted on October 17, 2023, from 7:00 am to 9:00 am in the morning and 5:00 pm to 7:00 pm in the evening, capturing comprehensive traffic data. The selected location ensured an unobstructed view extending 100 meters from the intersection.

Queue length analysis used video footage and Waze navigation. A car sample, directed to Waze, provided data at 20-minute intervals. Gap acceptance analysis utilized SIDRA software, focusing on the Persiaran Pulai Perdana intersection's operational performance.

Utilizing SIDRA version 9 software, we conducted a thorough assessment of the operational performance of the Jalan Persiaran Pulai Perdana intersection. Following methodologies from the Highway Capacity Manual (HCM 2010), the software computed intersection capacity by analyzing turning movements and geometric parameters. Inputting precise geometric parameters ensured accuracy in capacity data. The analysis considered each leg of the intersection, providing data on anticipated queue distances, approach delays, and Level of Service (LOS). These metrics collectively indicate the intersection's efficiency in managing current traffic volumes. The SIDRA model's predicted queue length was compared with on-site data, leading to deliberation on disparities. The analysis involved sequential steps, including entering intersection data, movement class, lane configuration, and pedestrian movement data. Vehicle volume data, gap acceptance, and vehicle movement data were also inputted. Configuring all parameters, the SIDRA model presented processed site results, including LOS and relevant performance parameters in the output. This detailed analysis contributes valuable insights into the intersection's functionality and potential areas for improvement.

This research enhances our understanding of traffic dynamics at Persiaran Pulai Perdana, offering insights for potential improvements. The comprehensive methodology and analysis contribute to the body of knowledge on traffic behavior and performance parameters, particularly in congested urban intersections (Chu & Ke, 2017).

3. Results and Discussion

The performance analysis of the Jalan Persiaran Pulai Perdana intersection involved a meticulous examination of traffic volume data collected during peak periods, specifically from 7:30 a.m. to 8:30 a.m. and 5:30 p.m. to 6:30 p.m. The acquired data served as a crucial foundation for assessing the intersection's present operational efficiency during peak hours. Converting the traffic volume into Passenger Car Equivalent (PCU/hr) using the relevant PCU factor associated with the intersection design enabled a standardized evaluation.

Averaging the data from both morning and evening peak hours resulted in a singular average traffic volume. Additionally, the percentage of heavy vehicles and the peak hour factor were averaged, considering data from both morning and evening traffic volumes. This comprehensive dataset was then inputted into the SIDRA version 9 software to conduct a thorough performance evaluation of the intersection, encompassing capacity, delay, queue length, and Level of Service (LOS).

During the on-site study, queue length measurements were meticulously conducted. The collected data was systematically compared with the output queue length generated by SIDRA, and the resulting disparities were discussed in detail. The performance analysis of the current intersection, focusing on capacity, delay, queue length, and LOS, provided a holistic evaluation of its operational efficiency. The concluding section of Chapter 4 presented well-considered recommendations for enhancing capacity and improving the Level of Service (LOS) with the overarching goal of optimizing traffic management at the Jalan Persiaran Pulai Perdana intersection.

Furthermore, to conduct a comprehensive assessment of the intersection's current operational efficiency, an extensive traffic volume survey was carried out. This involved monitoring traffic flows over one hour during peak hours on Wednesday, October 11, 2023, providing accurate and timely data on the intersection's traffic patterns.

3.1 Traffic Flow Moment Diagram

The traffic volume data, after conversion into PCU, was summarized into a traffic flow movement diagram depicting peak hours in the morning and evening, as illustrated in Figure 1 and Figure 2 below.

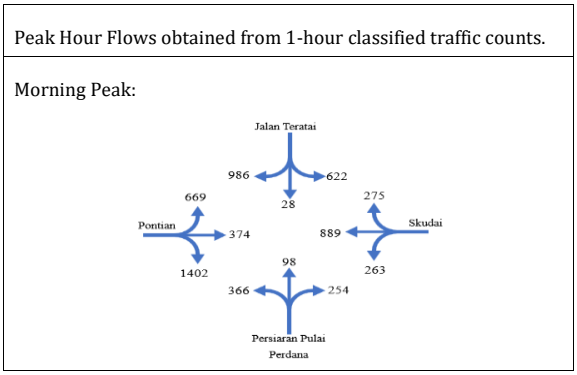

Fig 1 *Peak Hour Flows obtained from 1-hour classified traffic counts.*

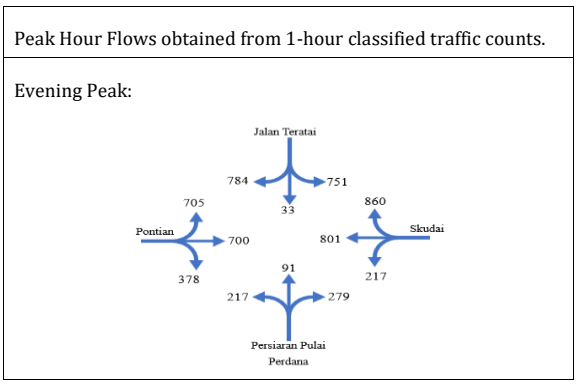

Fig 2 *Peak Hour Flows obtained from 1-hour classified traffic counts.*

The analysis of traffic volume data, converted into Passenger Car Units (PCU) and depicted in a traffic flow movement diagram, revealed pronounced busyness during peak hours in both the morning and evening periods. This observation underscores the significance of addressing traffic congestion during these specific time frames. The heightened vehicular activity during these peak hours suggests a substantial demand for transportation, emphasizing the need for strategic interventions to enhance traffic management and alleviate congestion. The findings underscore the importance of targeted measures and infrastructure improvements to optimize the flow of traffic, ensuring a more efficient and sustainable urban transportation system in the studied area.

3.2 Average Traffic Flow Diagram

The traffic flow movements during morning and evening peak hours were averaged, as shown in Figure 3. The average peak from Pontian to Persiaran Pulai Perdana were the highest compared to the others traffic flow.

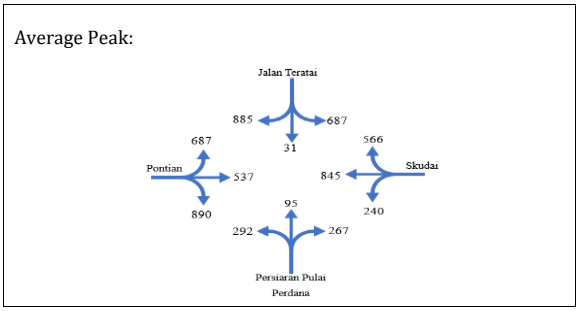

Fig 3 *Average traffic flow diagram*

The analysis of traffic flow movements during morning and evening peak hours, as presented in Figure 3, involved the calculation of averages. Notably, the data revealed that the average peak traffic flow from Pontian to Persiaran Pulai Perdana exhibited the highest magnitude in comparison to other traffic flows. This observation suggests a concentration of significant vehicular activity along this specific route during peak hours. Understanding and addressing the factors contributing to this heightened traffic flow, such as commuting patterns, road design, or urban development, becomes crucial for effective traffic management strategies. The findings underscore the need for targeted interventions and potential infrastructure improvements along the Pontian to Persiaran Pulai Perdana route to enhance the overall efficiency and sustainability of the transportation system in the studied area.

3.3 Queue Length Measured On-site

Figure 5 shows the queue distance average per lanes. The traffic movement from Skudai to Pontian and Pontian to Skudai is too slow due to the number of vehicles exceed the road capacity.

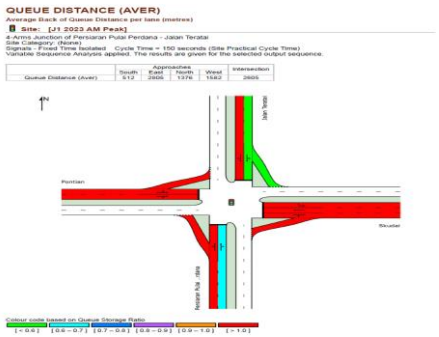

Fig 4 *Queue distance average per lanes*

The analysis of queue distance averages per lanes, as depicted in Figure 5, indicates notable congestion issues along the traffic movement from Skudai to Pontian and Pontian to Skudai. The observed slow traffic flow in these directions is attributed to the exceeding number of vehicles, surpassing the road capacity. This finding highlights a critical congestion challenge that warrants attention for effective traffic management and improved mobility. Addressing this issue may involve implementing measures such as optimizing signal timings, exploring alternative routes, or considering infrastructural enhancements to accommodate the demand and alleviate congestion. The identification of specific congested segments provides valuable insights for targeted interventions aimed at enhancing the overall efficiency and flow of traffic along these routes.

3.4 Data Analysis Using SIDRA

The Australian Road Research Board (ARRB) and Transport Research Ltd. developed the Signalized Intersection Design and Research Aid (SIDRA) software, which serves as an analytical tool for evaluating the operation and performance of various types of intersections, including signalized intersections, roundabouts, two-way stop control systems, and yield-sign control intersections. This study uses SIDRA version 9 to evaluate the performance of the intersection at Persiaran Pulai Perdana in terms of operational performance taking, capacity, level of service (LOS), queue length, and delay.

3.4.1 Intersection Performance in the Current Year 2023

SIDRA version 8 software was used to create the current evaluation of the Persiaran Pulai Perdana intersection. Figure 5 shows the intersection's capacity, delay, queue length, and Level of Service (LOS) in the observed year of 2023 also depicts the LOS for each lane approaching the intersection.

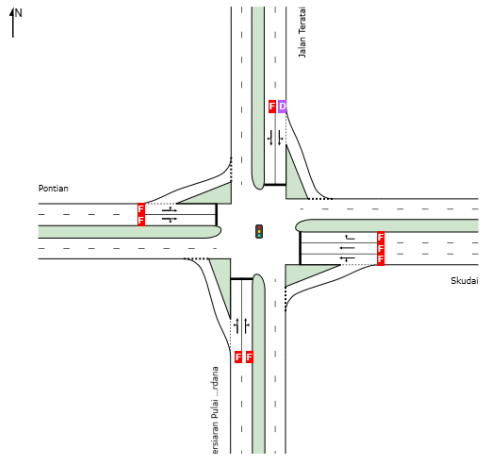

Fig 5 *the intersection's capacity, delay, queue length, and Level of Service (LOS)*

(1)

3.5 Proposed Capacity and LOS Enhancement

According to the proposed traffic management plan, the urban planning team meticulously developed a proposal to address the ongoing traffic congestion challenges at the current four-way intersection. The proposal meticulously outlines the introduction of a flyover as a transformative solution to alleviate the persistent congestion issues at the intersection. This intricately designed proposal comprehensively addresses the congestion issues that have afflicted the intersection, aiming to augment traffic flow and mitigate gridlock. Through the strategic integration of a flyover into the existing infrastructure, the anticipated outcome is a significant augmentation of road capacity, furnishing a practical and efficacious solution to accommodate the escalating vehicular volume during peak hours.

An urban planning committee proposes the envisioned flyover as a crucial intervention designed to address immediate congestion concerns and optimize the efficiency of vehicular movement at the intersection. This optimization strategy entails deliberately integrating dedicated lanes for specific directions and implementing sophisticated, intelligent traffic management systems. Transportation engineers meticulously designed these measures to minimize conflict points, streamline traffic patterns, and, ultimately, foster a more seamless and efficient transportation experience.

The envisaged flyover is poised to yield significant enhancements in travel time for commuters, surpassing its immediate amelioration of congestion. The resultant reduction in travel time is strategically positioned as a pivotal benefit, elevating the overall commuter experience, and fostering heightened economic productivity within the region. Moreover, the proposed infrastructure aligns strategically with broader objectives to enhance the local transportation system. It is envisioned as a catalyst for sustainable urban development, promoting superior connectivity and heightened regional accessibility.

Recognizing the indispensable requirement for a comprehensive impact evaluation, the proposal assimilates an exhaustive inquiry into the environmental and social implications of constructing the flyover. Proposed within the framework are meticulous mitigation strategies devised to address potential environmental concerns, accompanied by outlined measures strategically designed to minimize disruptions to local communities. This inclusive approach substantiates a steadfast commitment to responsible urban development, underscoring a conscientious consideration for the broader well-being of the environment and the community.

Regarding financial viability, the proposal thoroughly estimates costs, spanning construction expenses, technology integration, and potential land acquisition requisites. Identifying diverse funding sources, comprising government grants, private partnerships, and community contributions, exemplifies a strategic orientation to ensure the project's sustained viability and efficacious implementation.

Finally, active involvement from the community stands as a pivotal element strongly underscored by the proposal for ensuring the project's success. In order to include local businesses and residents in the decision-making process, proactive measures, including public forums, informational workshops, and feedback channels, are recommended. This cooperative method aims to address issues, win over people, and foster pride and ownership in the planned infrastructure project. The construction of a flyover is a comprehensive and progressive solution that can reduce traffic and stimulate improvements in community well-being, environmental sustainability, and transportation.

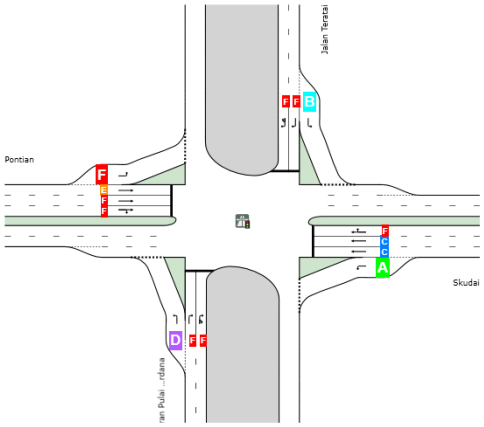

Fig 6 *Redesigning the new highway*

Following redesigning the new highway, an analysis using Sidra 9 revealed persistent congestion during morning hours. After a comprehensive investigation, experts determined that the congestion mainly results from residents utilizing the roadway to take their children to school in the morning. Additionally, in the evening, the section of the road leading from Skudai to Pontian experienced a downgrade in Level of Service (LOS) from F to C. In contrast, the LOS for the other section remained consistent at LOS F.

The analysis of queue distance averages per lanes for the proposed changes reveals significant improvements in specific lanes, notably the one leading to Pontian and Skudai. The successful mitigation of congestion in these areas is attributed to the widened road and the implementation of a flyover. This progress underscores the effectiveness of these enhancements, emphasizing the potential for further improvements in that particular area.

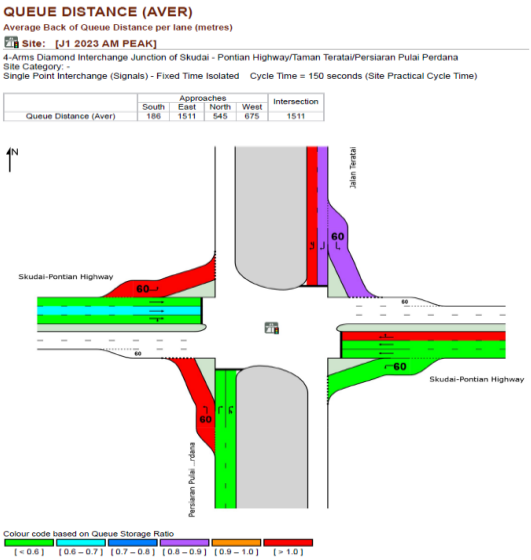

Fig 7 *Queue distance average redesigning new highway*

4. Conclusion

This study focuses on comprehensively analyzing the operational conditions at the intersection of Jalan Persiaran Pulai Perdana, particularly during peak hours when congestion is prominent. Using SIDRA version 9 software, data on traffic volume, geometric characteristics, road inventory, and queue length were systematically collected and analyzed in 2023. The findings reveal that most lanes exceeded their designated capacities, resulting in an overall Level of Service (LOS) rating of F, indicating an ineffective and congested operational state.

Elevated delays and queue lengths were observed in the south and west lanes throughout 2023, with nearly all lanes exhibiting an LOS rating of F during peak hours. This consistent LOS F indicates the intersection's incapacity to manage the heightened vehicular demand effectively. The study suggests enhancements to capacity and LOS for implicated lanes, proposing valuable insights for local authorities in prospective traffic management. The recommendation explores the relationship between intersections and flyovers, proposing that replacing the current intersection with a flyover can improve lane LOS from F.

The proposed methodology advocates for a flyover replacement, rooted in traffic data collected at the intersection. However, the study acknowledges limitations, particularly concerning the proposed strategy. Empirical evidence is deemed imperative to substantiate assumptions, and further investigations are needed for a thorough performance analysis using methods aligned with the preferred flyover construction approach.

Subsequent research recommendations involve a meticulous analysis of the envisaged flyover design's performance, utilizing an application suitable for data input from Jalan Persiaran Pulai Perdana. This prospective study is crucial for gauging the efficacy of the current intersection and validating assumptions made in the initial study. The culmination of this research, including an evaluation of four intersections and a performance analysis of the desired flyover design, aims to facilitate enhanced traffic management on Jalan Persiaran Pulai Perdana by the local authority, MBIP.

Acknowledgement

Thank you for the valuable feedback and insights that have contributed to the improvement of my work. I am honored to be part of the academic community at Universiti Tun Hussein Onn Malaysia and look forward to the possibility of contributing to the body of knowledge in our field.

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