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AN ASSESSMENT OF MODAL SPLIT AND OCCUPANCY OF VEHICLE ON URBAN ROUTE: THE CASE STUDY OF JALAN PAHANG, KUALA LUMPUR, MALAYSIA

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Abstract

Urban transportation in Kuala Lumpur, particularly along Jalan Pahang, faces severe congestion due to an increasing number of private vehicles. This study assesses the modal split, identifies influencing factors, and evaluates public transportation efficiency. Using CCTV footage, data was collected from camera registered as CN275 (inbound) and CN290 (outbound). Findings indicate that private vehicles dominate, with over 70% being Single Occupancy Vehicles (SOVs), while High Occupancy Vehicles (HOVs) and buses remain underutilized. This highlights an inefficient transport system. The study suggests that road expansion projects alone will not alleviate congestion but may instead encourage more private vehicle use. The research recommends enhancing public transportation services, adopting intelligent traffic management systems, and implementing policies to promote HOVs, ultimately fostering sustainable urban mobility.

Keywords: High Occupancy Vehicle (HOV), Single Occupancy Vehicle (SOV), Modal Split, Traffic Congestion, Public Transport.

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INTRODUCTION

Malaysia's transport system has evolved significantly since British colonial rule; however, Kuala Lumpur continues to experience severe congestion due to excessive reliance on private vehicles. Despite an extensive road network spanning 290,099.38 km, public transport inefficiencies persist due to limited accessibility, unreliable services, and inadequate route coverage. Rapid urbanization exacerbates these issues, leading to longer travel distances and reinforcing car dependence, particularly on SOVs.

Malaysia's transport system has evolved since British colonial rule transitioning from basic road networks to an expansive infrastructure supporting national connectivity. However, despite this development, Kuala Lumpur continues to face severe traffic congestion, primarily due to the public's heavy reliance on private vehicles. Based on Ariffin, R. N. R. et al. (2013), the growing urban population and increasing household incomes have led to a rise in motor vehicle ownership. With a road network extending 290,099.38 km across the country, Malaysia has made considerable investments in its transportation infrastructure. Despite an extensive road network, public transport remains inefficient due to poor accessibility, unreliable services, and route constraints. Rapid urbanization has further contributed to longer travel distances and reinforced car dependence, making private vehicles, particularly SOVs, the dominant mode of transport. However, public transport remains inefficient due to several critical challenges, including:

- Poor Accessibility – Many areas in Kuala Lumpur and its surrounding regions are underserved by public transit, making it difficult for commuters to rely on buses and trains for daily travel.
- Unreliable Services – Public transport often experiences delays, breakdowns, and inconsistent scheduling, leading to passenger dissatisfaction and a preference for private vehicles.
- Route Constraints – Limited transit routes and inadequate coverage in suburban and developing areas further discourage public transport use.

These issues are exacerbated by rapid urbanization, which has contributed to increasing travel distances and reinforcing car dependency. As a result, private vehicles, particularly SOVs, dominate the city's transport landscape, worsening traffic congestion and environmental pollution. This study examines the modal split along Jalan Pahang by analysing travel behaviour and its impact on congestion while exploring solutions for a more balanced transport system. It evaluates the ratio of SOVs to HOVs and buses, assesses the limitations of current CCTV-based data collection, and explores how Artificial Intelligent

(AI) and Internet of Thing (IoT) can enhance transport data accuracy and planning.

The objective of this study is to analyse the modal split along Jalan Pahang focusing on Single Occupancy Vehicles (SOVs), High Occupancy Vehicles (HOVs), and bus utilization. and explore solutions to foster a more balanced and sustainable transport system in Kuala Lumpur. It evaluates the ratio of SOVs to HOVs and buses, assesses the effectiveness of current data collection methods, and investigates technological advancements for transport planning. It assess the limitations of CCTV-based data collection in capturing accurate modal split information and explore alternatives or integration of AI and IoT to improve transport planning with an aims to provide recommendations for sustainable transportation policies to address congestion effectively. By identifying existing gaps in the transportation system, this study seeks to develop strategies that promote a more balanced and efficient modal split, ultimately encouraging the shift from private vehicles to high-occupancy and public transport options.

LITERATURE REVIEW

Transportation In Kuala Lumpur

Kuala Lumpur's road network plays a crucial role in both economic and social development, spanning approximately 330,000 square kilometres. A well-maintained transportation infrastructure enhances a city's global competitiveness and economic viability (Chuen et al., 2014). As the capital of Malaysia, Kuala Lumpur's strategic central location and well-established administrative framework have significantly contributed to its rapid growth, fostering advancements in transportation, governance, and economic expansion.

Historically, the city's transportation network has evolved alongside its urban development. The railway transport system was the earliest transport network since the late 19th century, stimulating economic and urban expansion and reinforcing Kuala Lumpur's role as a major economic hub (Wahab 1990). The period between 1984 and 1999 saw the implementation of several major road infrastructure projects, including the Kuala Lumpur Traffic Dispersal Scheme, Inner and Middle Ring Roads, and the Radial Urban Highway. These projects aimed to facilitate smoother traffic flow and accommodate the growing number of vehicles on the road. Urban development efforts during this period were concentrated within the Central Planning Area, as well as four New Growth Areas: Damansara, Wangsa Maju, Bukit Jalil, and Bandar Tun Razak

Figure 1: Road length in 1990,2000,2021
Source: Kuala Lumpur Structure Plan 2040

The development of public transportation began in 1995 with the introduction of Commuter Services, followed by the launch of the STAR and PUTRA Light Rail Transit (LRT) systems (Kuala Lumpur Structure Plan 2040). These initiatives marked a significant step towards establishing an integrated public transport system within the city. However, despite these efforts, road expansion has consistently outpaced railway development, leading to a transportation system that remains heavily reliant on private vehicles. In 1990, the total length of roads in Kuala Lumpur was 96.52 km, compared to just 41 km of railway lines, with a single railway station in operation. By 2021, the road network had expanded significantly to 342.25 km, whereas railway infrastructure, though improved, only reached 156 km, with 103 stations. This imbalance has resulted in a transport system that continues to be dominated by roads, leading to severe traffic congestion and escalating environmental concerns.

The rapid pace of urbanization and ineffective land use planning have further exacerbated traffic congestion in Kuala Lumpur. Many newly developed areas lack adequate access to public transport, forcing residents to rely on private vehicles for their daily commutes. Chee (1991) criticized Kuala Lumpur's urban planning strategy, arguing that it failed to effectively address traffic congestion. The city's development patterns have often been compared to those of North American suburbs, where urban sprawl and car dependency prevail due to the absence of well-integrated public transportation networks. Additionally, many housing estates in Kuala Lumpur have not been designed to support efficient public transit systems, further limiting accessibility and usage.

Table 1: Length of Road and Railway and Number of Stations

Year	Road	Railway	Station	Percentage
1990	96.52 km	41km	1	-
2000	259.65km	94km	66	21%
2021	342.25km	156km	103	24.2%

Source: Kuala Lumpur Structure Plan 2040

Key Transportation Challenges in Kuala Lumpur

Kuala Lumpur faces three primary transportation challenges that contribute to worsening congestion and inefficiencies in urban mobility:

1. High Dependency on Private Vehicles

The majority of Kuala Lumpur's residents rely on private cars due to shortcomings in the public transport system. Overcrowding, frequent delays, and safety concerns deter commuters from using public transit, leading to increased SOV usage. While private vehicles provide convenience and flexibility, they significantly contribute to road congestion, air pollution, and increased travel times.

2. Urban Sprawl and Long Commutes

The expansion of Kuala Lumpur's metropolitan area has resulted in urban sprawl, forcing residents to travel longer distances for work, education, and daily activities. Although transit-oriented development (TOD) initiatives have been introduced to integrate housing with public transport networks, their implementation has not been effective in reducing congestion. Many residents still find it more convenient to use private vehicles rather than rely on underdeveloped public transport options.

3. Outdated Data Collection Methods

The use of outdated CCTV systems to monitor traffic and modal split presents a major obstacle to effective policymaking. Current surveillance systems lack the ability to accurately classify vehicle types, count occupancy rates, and analyze real-time transport patterns. This results in unreliable data, making it difficult for authorities to design evidence-based transportation policies. The inability to capture precise modal split data further prevents targeted interventions aimed at reducing SOV dominance and promoting HOVs and public transport.

Public Transportation In Kuala Lumpur

Public transportation in Kuala Lumpur, comprising buses, rail services, and taxis, has experienced moderate development over the years. While significant efforts have been made to expand and modernize the public transport system, challenges related to accessibility, efficiency, and public preference for private vehicles continue to hinder its full potential in addressing urban mobility issues.

Before the 1990s, buses served as the primary mode of public transportation in Kuala Lumpur. Due to the lack of a well-integrated rail system, commuters heavily relied on bus services to travel within the city and its surrounding areas. However, as urbanization accelerated, the need for a more efficient and extensive public transport network became evident. By 2000, Kuala Lumpur's public transport infrastructure had expanded significantly, with the city boasting 209 km of electrified rail lines, including commuter trains operated by KTM and Light Rail Transit (LRT) systems (Hidayati et al., 2021) These developments were aimed at reducing congestion and providing an alternative to private vehicle use. However, despite these improvements, public transport ridership has seen a steady decline in recent years, while private vehicle ownership has continued to rise. This trend has exacerbated traffic congestion, undermining the efforts to create a more sustainable urban transport system (Tham & Anuar, 2012).

The current Public Transport Infrastructure in Kuala Lumpur are Buses and Rail Services. The Buses play a crucial role in Kuala Lumpur's public transport system by complementing rail services and providing connectivity to areas not directly served by the train network. The city currently operates an extensive bus network, which includes:

- 83 Rapid Bus routes, serving key residential and commercial areas.
- 14 GoKL routes, offering free bus services to improve urban mobility.
- 17 other stage bus routes, catering to commuters in various districts (Kuala Lumpur Structure Plan 2040).

Despite the availability of multiple bus routes, accessibility remains moderate, primarily due to poor route planning, inconsistent scheduling, traffic congestion, and insufficient coverage in suburban areas. Many commuters still find bus travel inconvenient due to long waiting times, overcrowding, and unreliable services. Additionally, lack of dedicated bus lanes on major roads, including Jalan Pahang, further reduces the efficiency of bus services, making private vehicle use a more attractive option for daily commuters.

Rail Network

Kuala Lumpur's rail system, which consists of Express Rail Link (ERL), monorail, KTM commuter trains, and Light Rail Transit (LRT), appears extensive on paper. However, low ridership and inefficiencies have prevented it from becoming the dominant mode of transport. While rail services offer relatively faster travel times compared to buses, several factors contribute to the underutilization, including:

- Limited last-mile connectivity - Many rail stations are not well-integrated with feeder bus services, making it difficult for passengers to reach their final destinations conveniently.
- Inconsistent service frequency - Train intervals, particularly during non-peak hours, are often long, discouraging ridership.
- Overcrowding during peak hours - Although ridership remains low overall, commuters frequently experience overcrowding on popular routes during rush hours, reducing passenger comfort.
- High fares compared to perceived service quality - Some commuters find rail fares relatively high, especially when considering the service reliability and accessibility challenges.

As a result of these limitations, many residents prefer private vehicles over public transport, further aggravating congestion in the city. Without improvements in reliability, frequency, and connectivity, Kuala Lumpur's rail system will struggle to compete with the convenience of personal car usage.

Private Vehicle and The Rise of Car Ownership

Private cars have become the dominant mode of transport due to their convenience, door-to-door access, and status symbol. Car ownership in Malaysia is rising, with 17.2 million registered cars, surpassing motorcycles and goods vehicles (Daim, 2023). In 1980, 65% of trips into Kuala Lumpur were made by private cars, increasing to 67.4% in 1990, while public transport use declined. The rising number of vehicles has led to traffic congestion, pollution, and environmental degradation (Abdullah, 2010).

Experts, including Dr. Khulanthayan, emphasize that building more roads is not a solution; instead, demand management and investment in public transport, especially rail-based systems, are crucial. Rail transport is safer, congestion-free, and punctual, while buses remain the safest road-based transport. To tackle congestion, promoting ridesharing (HOV) over single-occupancy vehicles (SOV) is an efficient and cost-effective strategy, reducing reliance on expanding infrastructure while optimizing existing resources. This aligns with the research aim of enhancing public transport and encouraging shared mobility.

Factors Influencing the Increase in Car Ownership

Car ownership is influenced primarily by income, with wealthier individuals purchasing more cars as a status symbol. A study by Azhar & Zahari (2022) found that 72.4% of the B40 group view cars as a necessity, despite traffic congestion. However, M40 (13.5%) and T20 (1.6%) show lower car dependency. Many still rely on private vehicles due to limited public transport options. Malaysia's easy access to car ownership with financing options and affordable second-hand vehicles contrasts with Singapore's strict policies. In Singapore, buyers must obtain a Certificate of Entitlement (COE) and pay multiple government fees, significantly increasing costs and controlling car numbers (Chan, 2025). Additionally, Singapore enforces a 10-year COE renewal system, while Malaysia lacks an End-of-Life Vehicle (ELV) policy, leading to rising vehicle numbers and worsening congestion. By 2040, Malaysia's registered passenger cars are expected to reach 12.64 million (Kassim et al., 2020). To curb car dependency, implementing an ELV policy, ownership fees, and improved public transport could promote sustainability and reduce congestion.

Modal Split

A study by Mohamad (2017) on work trip travel patterns in Kuala Lumpur found that 92.6% of commuters use a single mode of transport, with limited intermodal travel due to difficulties in transferring between different transportation options. The findings also indicated a higher prevalence of private car usage compared to public transport. The study explored the impact of socio-demographic factors on travel behavior, categorizing commuters into four main groups: private car users, public transport users, non-motorized travellers (cyclists/pedestrians), and multimodal commuters. By comparing these groups, the research aimed to identify key differences in travel patterns.

In 2022, the modal split between public transport and private vehicles was 25:75, highlighting the dominance of private cars. To tackle congestion, the Traffic Master Plan 2040 (PITKL2040) focuses on enhancing public transport efficiency, accessibility, and safety to encourage a shift away from private vehicles. One successful global example is South Korea's Cheonggyecheon project, where an elevated freeway was demolished and replaced with a sustainable urban space. Despite initial concerns about the cost of the restoration, a total of 281 million USD was reportedly spent solely on the restoration. The project improved traffic flow, increased land value, and led to a rise in bus and subway ridership. (Landscape Performance Series, 2024).

Policy And Issues of Urban Sprawl in Malaysia

Urban sprawl, emerging in the late 20th century, is marked by low-density development, heavy reliance on private cars, traffic congestion, and

environmental issues (Naeem et al., 2016). Greenbelts and urban growth boundaries help limit sprawl, conserve land, and promote compact development, reducing infrastructure costs. Successful implementation requires high-density areas supported by public transport (Naeem et al., 2016).

Malaysia's 2006 urbanization policy proposed growth boundaries, but poor coordination between federal and local governments hindered enforcement. Despite efforts like the 2011 MRT expansion, urban development continues along major transport routes (Naeem et al., 2016).

Kuala Lumpur's 2021 land use data highlights extensive urbanization (78.8%), with limited undeveloped land (21.2%) (Kuala Lumpur Structure Plan 2040). The TOD (Transit-Oriented Development) strategy aims to increase density near public transport hubs, expand rail networks, and optimize land use to curb sprawl. However, TOD requires large land areas, raising concerns that current policies focus more on accommodating growth than controlling it.

Data Collection Method

Traffic congestion is classified into Recurrent Congestion (RC) and Non-Recurrent Congestion (NRC) (Anbaroglu et al., 2014). RC occurs daily during peak hours, caused by high travel demand, inadequate capacity, or poor signal control (Han & May, 1989). NRC is unpredictable, caused by accidents, vehicle breakdowns, weather, or special events (Dowling et al., 2004). Advancements in smart transportation use CCTV and IoT for traffic management, logistics, and safety (Dewi, 2021). China enhances traffic monitoring with drones using TPH-YOLOv5++ technology, which improves detection speed and accuracy while reducing computational costs (Zhao et al., 2023).

Increase The Rate of HOV Compared To SOV

Every day, 6 million vehicles enter Kuala Lumpur, with 2.2 million doing so during peak hours (Law, 2024). While enhancing public transportation is essential, additional measures are necessary, as Malaysians heavily rely on private cars. Some propose solutions to address issue of congestion include Variable Charging Based on Occupancy, Time-of-Day Pricing, and Integration with Public Transport to encourage carpooling and reduce traffic congestion (Tan, 2024). Singapore's Electronic Road Pricing (ERP) system, which adjusts toll rates based on real-time traffic conditions, has proven effective in managing congestion (Tan 2024) Additionally, a double-decker bus can replace 53 to 100 private cars, significantly reducing both traffic congestion and carbon emissions (Ortúzar, 2019). However, for this shift to be successful, public transport must be reliable, offering real-time updates, improved accessibility, and better infrastructure (Bachok et al., 2008; Soh et al., 2014). By implementing congestion-based pricing and enhancing transit systems, Kuala Lumpur can take

significant steps toward easing traffic congestion and promoting sustainable urban mobility.

RESEARCH METHODOLOGY

This study adopts a quantitative research approach to analyze modal split calculations and data collection methods for urban travel in Kuala Lumpur. Primary data is obtained through on-site surveys and direct observations conducted at key locations, focusing on critical factors such as travel patterns, mode choices, trip purposes, and user demographics. To ensure a comprehensive representation of urban travel behavior, survey respondents include daily commuters, students, and working professionals. Additionally, observational data is recorded to validate self-reported responses, offering deeper insights into traffic conditions and mode share distribution.

Secondary data is sourced from government reports, transport authority databases, and academic studies to complement the primary data and provide contextual background for analysis. This includes information on existing transportation policies, infrastructure development plans, and demographic statistics that influence urban mobility trends. The collected data is processed and analysed using statistical methods, including descriptive analysis and regression modelling, to identify key factors affecting mode choice.

ANALYSIS AND DISCUSSION

This study examines traffic patterns and modal split along Jalan Pahang in Kuala Lumpur to gain a deeper understanding of urban travel behavior. Data was collected using CCTV footage to analyze the preference for various transport modes, including Single-Occupancy Vehicles (SOVs), High-Occupancy Vehicles (HOVs), and buses. The findings offer valuable insights into traffic volume, vehicle usage trends, and the challenges associated with achieving an efficient transportation system.

The research employed a quantitative approach, supplemented by observational data from CCTV recordings. Data collection was conducted on Tuesdays, Wednesdays, and Thursdays during peak hours, specifically from 7:00 AM to 9:00 AM and 6:00 PM to 8:00 PM. The study focused on two key locations: CN275 Jalan Pahang (inbound) and CN290 Jalan Pahang (outbound). The traffic count encompassed private cars, motorcycles, and buses, with data recorded at 15-minute intervals to ensure accuracy and reliability.

Traffic Volume

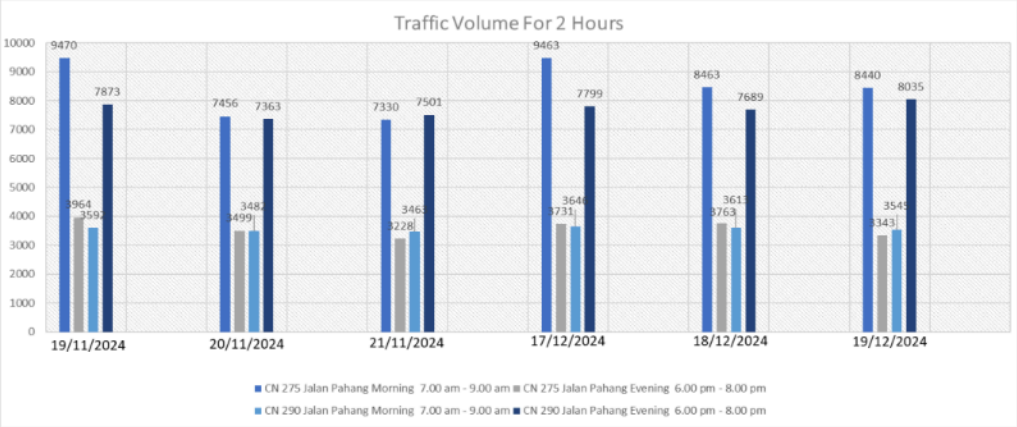

Figure 2: Graph on Traffic Volume for 2 Hours
Source: Field study

The analysis revealed a notable variation in traffic volume between morning and evening peak hours. In the morning, the highest inbound traffic was recorded at CN275 Jalan Pahang, with 9,470 vehicles on November 19, 2024. Conversely, the highest outbound traffic was observed at CN290 Jalan Pahang in the evening, reaching 8,035 vehicles on December 19, 2024. These findings highlight that Jalan Pahang serves as a major commuting corridor, with a significant influx of vehicles into the city in the morning and a substantial outflow in the evening.

Additionally, a comparison between peak-hour traffic and Average Daily Traffic (ADT) revealed that peak-hour travel accounts for 16% of total daily traffic, while off-peak hours contribute only 6%. This indicates that traffic congestion is predominantly a peak-hour issue, suggesting that redistributing traffic loads through improved transport policies and demand management strategies could help alleviate congestion.

Vehicle Preferences

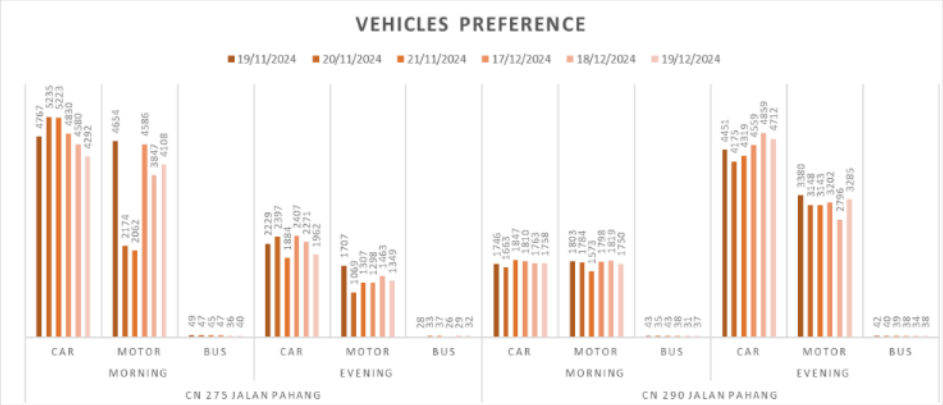

Figure 3: Graph of Vehicle Preference
Source: Field study

The findings confirm that private vehicles, particularly cars, dominate the road network, followed by motorcycles, while buses remain the least used mode of transport. Many commuters prefer private cars due to their convenience, reliability, and perceived status. However, this reliance on private vehicles caused congestion, especially during peak hours.

Car Occupancy Analysis

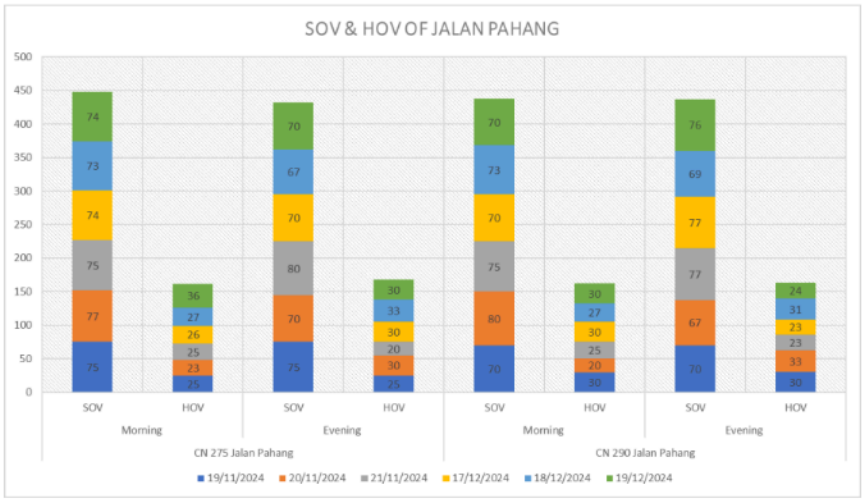

Figure 4: SOV & HOV of Jalan Pahang
Source: Field Study

One of the key challenges identified is the high prevalence of Single-Occupancy Vehicles (SOVs). The data revealed that most cars carried only one passenger, leading to inefficient road usage and exacerbating congestion. Despite its potential to alleviate traffic, carpooling (HOVs) remains minimal. Historical data from Mohamad and Kigundu (2007) showed that 70% of vehicles crossing major ring roads in Kuala Lumpur were SOVs. If this trend persists, traffic congestion will continue to escalate.

Bus Occupancy

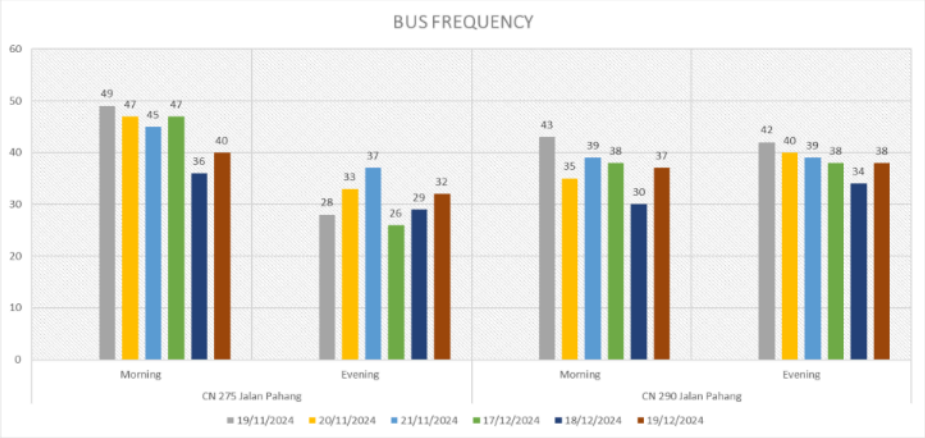

Figure 5: Bus Frequency
Source: Field study

As seen in Figure 4 bus frequency and occupancy along Jalan Pahang. The data revealed that bus frequency is inadequate, averaging only 24 buses per hour per direction during peak hours. While some buses operated at full capacity, others ran with half or even quarter-full loads. This suggests that buses may not be available frequently enough to meet demand, or that they are not attractive enough for commuters.

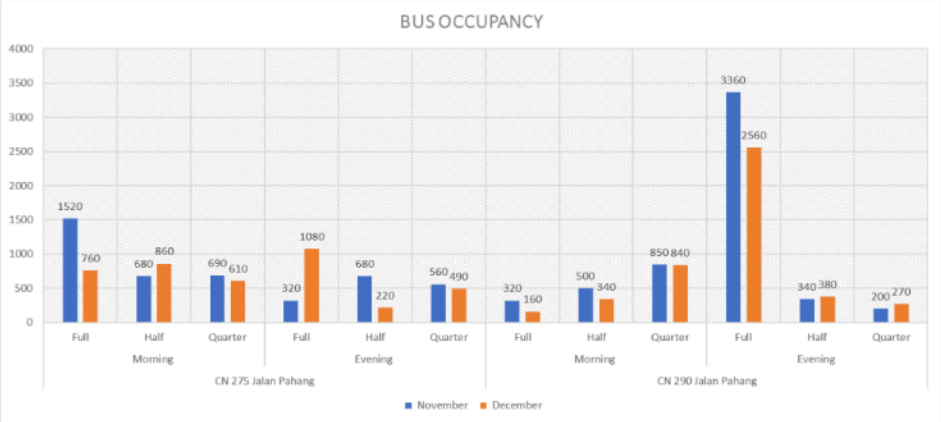

Figure 6: Bus Occupancy
Source: Field study

A comparison of morning and evening bus ridership, as shown in Figure 5, revealed that buses departing Kuala Lumpur in the evening were more crowded than those arriving in the morning. This suggests a potential mismatch between service availability and passenger demand.

Modal Split

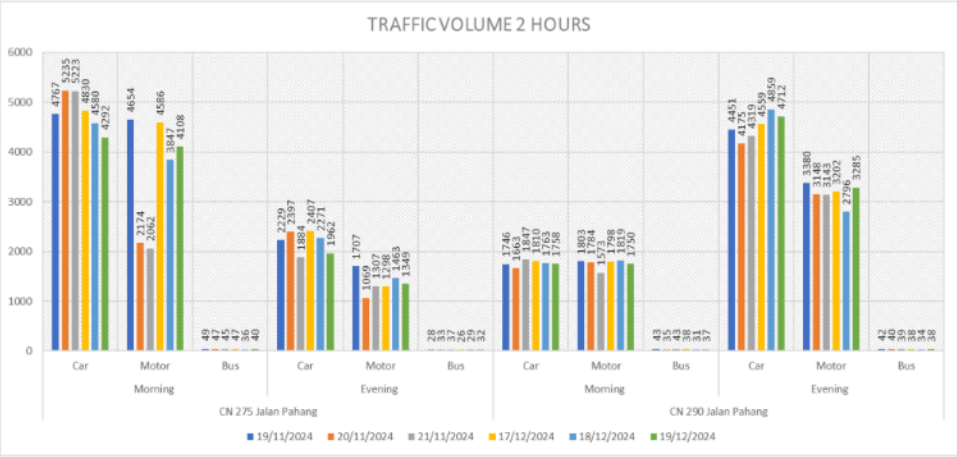

Figure 7: Traffic Volume For 2 Hours By vehicles
Source: Field study

Figure 8: Modal Split in the Morning CN275 Jalan Pahang
Source: Field study

The study analyzed the modal split for Jalan Pahang, categorizing transport usage into three groups: Single-Occupancy Vehicles (SOVs), High-Occupancy Vehicles (HOVs), and buses. The findings confirmed that private vehicles remain the dominant mode of transport, while buses account for only a small fraction of total trips, as illustrated in Figures 6 and 7. Currently, Kuala Lumpur's modal split stands at 25:75 in favor of private vehicles, falling significantly short of the city's 70:30 public transport target set for 2040.

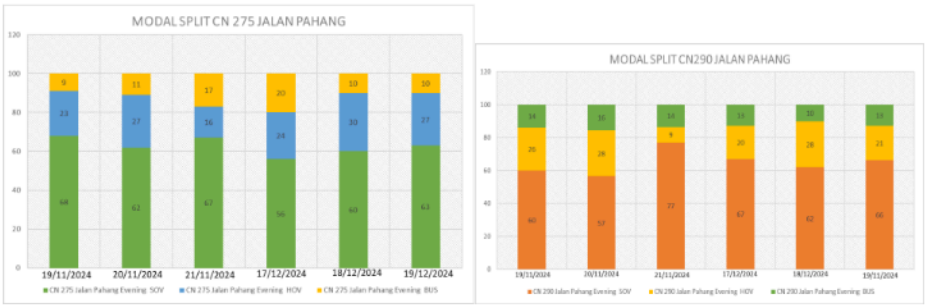

Figure 9: Modal Split in the Morning CN290 Jalan Pahang
Source: Field Study

If current trends persist, Kuala Lumpur will face significant challenges in achieving its public transport goals, leading to worsening traffic congestion. Strengthening bus services and encouraging carpooling are crucial steps toward creating a more balanced and efficient transportation systrm.

INFERENTIAL ANALYSIS

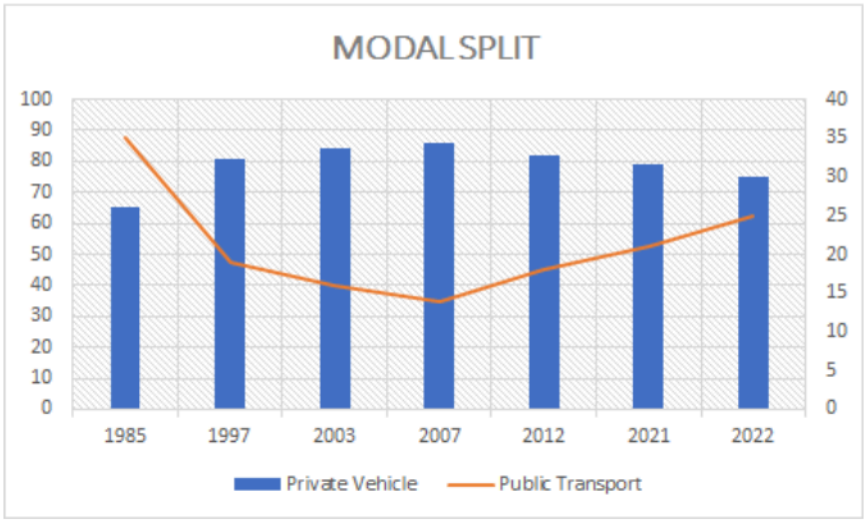

Figure 10: Modal Split of Kuala Lumpur
Source: KLCCC

Kuala Lumpur's modal split is 25:75, favouring private vehicles over public transport while the Kuala Lumpur City Council aims for 70:30 by 2040. However Figure 9 show a declining trend of public transport use and this can be a factor that worsen the congestion in Kuala Lumpur.

Table 2 : Regression Analysis

Types	Coefficients	Standard Error	t Stat	P-value
Intercept	0.232881717	2.586776571	0.090027767	0.930478337
X Variable 1	0.38970924	0.04034605	9.65916703	1.09898E-05

Regression analysis identified a strong correlation between car dependency and traffic congestion but a weak relationship between private vehicle use and public transport expansion. This indicates that increasing road capacity alone will not resolve congestion. Achieving the 70:30 target requires improvements in public transportation, increased bus frequency, and effective carpooling incentives. Without these measures, traffic congestion will continue to escalate.

RECOMMENDATION

The decline in public transport ridership and the increase in car dependency pose significant challenges for Kuala Lumpur's sustainable urban development. The existing transport system is unable to effectively reduce congestion, lower carbon emissions, and provide an attractive alternative to private vehicle use. To address these issues, it is crucial to implement targeted improvements, particularly in areas like Jalan Pahang, where heavy traffic congestion remains a persistent problem. The recommendation of the study are:

1. ***Improved Data Collection and Traffic Monitoring***
   Data collection should be taken during peak hour and the technology should be upgraded for more accurate data for example in China where they are using advanced technologies like AI, IoT, and drones using TPH-YOLOv5++ can improve data efficiency. Also, tracking SOVs, HOVs, and bus services will further enhance data accuracy on transportation and will able to improve the gap in transportation in order to achived 70:30 of public transport and private vehicle modal split.

2. ***Promoting Public Transportation and Carpooling by Giving Incentives***
   Lowering public transport costs through subsidies or discounts makes it more affordable, encouraging people to switch from cars to public transport. Offering off-peak discounts helps prevent overcrowding. Additionally, toll discounts for carpooling incentivize shared rides, promoting HOV usage. This practice can help reduce congestion during peak hours.

3. ***Expanding and Enhancing Public Transport Networks***
   As Malaysia moves towards 2030, upgrading the public transport system is essential. Modernizing buses can improve safety and attract more users. Displaying bus schedules at stops ensures reliability beyond websites. Real-time tracking provides accurate arrival times, making public transport accessible for all ages. A reliable, extensive system can encourage a shift from private vehicles, reducing congestion. Improving overall public transport infrastructure will further enhance service quality.

4. ***Implementing Electronic Road Pricing at Hotspots Prone to Traffic Congestion***
   Electronic Road Pricing (ERP) charges vehicles for using specific roads during peak hours or in congested areas. This helps reduce traffic, lower pollution, and encourage public transport use. By increasing driving costs during peak times, ERP discourages unnecessary trips, easing congestion and improving travel time reliability. It is most effective where efficient public

transport offers a convenient alternative, emphasizing the need to enhance public transport infrastructure.

5. ***Strengthening Policies with End-of-Life Vehicle (ELV) Regulations, Make Car Purchases More Restrictive and Mandate Public Transport For Workers.***
   Strengthen policies by implementing End-of-Life Vehicle (ELV) regulations to ensure proper vehicle disposal and recycling, reducing environmental hazards and promoting sustainability. This can also help lower the number of cars in Malaysia. Additionally, stricter car purchase measures, such as higher taxes, stricter loan approvals, or quotas, can discourage excessive private vehicle ownership. Mandating public transport for workers and allowing private vehicles only with at least four passengers can ease traffic, reduce emissions, and promote sustainable commuting in the same time increase the HOV rather than SOV.

6. ***Implementing Sustainable Mobility***
   Incorporate sustainable transportation policies into city planning, such as mixed-use zoning, cycling paths, and pedestrian-friendly streets, to reduce car dependency. This promotes sustainable urban mobility, reduces congestion, and makes public transport more appealing. The Ministry of Transportation should collaborate with planners to improve zoning and address issues like urban sprawl.

CONCLUSION

To alleviate congestion in Kuala Lumpur, it is essential to enhance bus frequency and expand route coverage, particularly during peak hours, to improve the reliability of public transportation. Implementing carpooling incentives, such as High-Occupancy Vehicle (HOV) lanes and toll discounts, can help reduce the number of Single-Occupancy Vehicles (SOVs) on the roads. Additionally, optimizing bus routes, refining schedules, and ensuring punctual service will make public transport a more attractive alternative to private vehicles.

Stronger transportation policies, including congestion charges and restrictions on private vehicle usage, can further encourage commuters to shift towards public transit. The integration of AI-based traffic management systems can enhance real-time monitoring, optimize traffic flow, and reduce delays. Furthermore, improving first- and last-mile connectivity through well-designed pedestrian walkways and dedicated bike lanes will promote sustainable mobility and decrease reliance on private cars.

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