Understanding Bicycle Lane Misuse: Key Factors and Road Safety Concerns

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Abstract: Dedicated bicycle lanes have been introduced to enhance cyclist safety, but misuse by other road users poses risks. This study examined misuse through field observations at midblock and intersection sites in Kuala Lumpur, Cyberjaya, and Shah Alam. A total of 3,527 observations were recorded over nine days across different time periods. Misuse was defined as the use of bicycle lanes for driving, walking, or parking by non-cyclists. Binary logistic regression was applied to assess demographic and contextual factors influencing misuse. Findings indicate that female road users were more likely to misuse bicycle lanes at both locations. Passenger cars were significantly more likely to encroach at intersections, while the presence of bus laybys reduced misuse across both road types. These results highlight the need for targeted awareness campaigns, policy refinements, and infrastructure improvements such as protected intersections and strategically placed bus laybys to improve cyclist safety and promote safer road interactions.

Keywords: Road Safety, Cycling, Other Road Users, Malaysia, Driving Behaviors, Female Driver

1. INTRODUCTION

Road safety has gained significant attention globally due to the continuous increase in traffic-related incidents. The World Health Organization (WHO) reported an estimated 1.19 million road deaths in 2021 (WHO, 2023). Of these fatalities, 53% involved vulnerable road users, with cyclists accounting for 6% (WHO, 2023). In Europe, 2,035 cyclist fatalities were recorded in 2019, representing 9% of total road deaths in the region (ERSO, 2021), while in the United States, cyclist fatalities increased by 13% in 2022 (Strohman, 2024).

In Malaysia, cycling activity is on the rise, particularly in urban areas. However, this has been accompanied by a growing number of crashes involving cyclists. Recent reports indicate that 70% of bicycle-related crashes result in fatalities, accounting for approximately 2% of total road deaths (Roslan et al., 2021). These alarming figures highlight the urgent need to address cyclist safety in the Malaysian context."

Various types of bicycle lanes exist in Malaysia, including exclusive bicycle lanes, delineated bicycle lanes, and shared bicycle and pedestrian lanes. A study in Melbourne, Australia, found that all types of bicycle lanes are generally effective, particularly in areas with higher speeds, narrower traffic lanes, and the presence of bus routes and tram stops (Morrison, Thompson, Kondo, & Beck, 2019). However, the study identified exclusive bicycle lanes as the most effective in reducing crash odds across all study settings. In the Malaysian context, delineated lanes are the most commonly used but are often obstructed by parked vehicles or misused by other road users, limiting their effectiveness in protecting cyclists. Due to the absence of physical separation and weak enforcement, these lanes do not provide the same safety benefits as exclusive or protected bicycle lanes. PLANMalaysia recommends a minimum bicycle lane width of 1.5 meters (PLANMalaysia, 2013), but obstacles such as parked cars and construction sites frequently obstruct these lanes, forcing cyclists into traffic and increasing accident risks (Torrance et al., 2009). These issues highlight the need for improved infrastructure planning and targeted policies to enhance cyclist safety.

Previous studies have shown that bicycle lane misuse is a common issue in urban environments, often caused by a combination of poor infrastructure design, lack of public awareness, and inadequate enforcement. Inadequate or poorly designed bicycle lanes, such as narrow lanes or those lacking clear separation from motor traffic, lead to frequent lane-changing and encroachment by both cyclists and vehicles, increasing the risk of accidents and misuse (Fistola et al., 2020). Many on-street bicycle lanes in Malaysia are not physically separated from motor vehicle lanes. As a result, they are often shared with parked vehicles, especially in busy city areas. This leads to frequent obstruction of the lanes by cars, vans, and even buses, forcing cyclists to swerve into traffic or onto pedestrian walkways (The Sun, 2025).

Street parking often creates hazardous conditions for cyclists by reducing available roadway space and increasing conflicts between vehicles and bicycles. A report by the FHWA highlights that parked vehicles obstruct visibility, making it difficult for drivers and cyclists to see each other (Schultheiss, Goodman, Draper, & Blackburn, 2021). Additionally, on-street parking forces cyclists to weave in and out of traffic or ride on sidewalks, further increasing accident risks (Torrance et al., 2007). These challenges underscore the need for careful roadway planning to ensure that bicycle lanes remain safe and well-protected.

In Malaysia, urban areas feature two types of bus stops: standard bus stops, where buses halt on the traffic lane, and bus laybys, which provide designated stopping areas outside the traffic lane. Bus laybys play a crucial role in urban road design by separating buses from general traffic, reducing conflicts with cyclists and other road users. Properly designed bus laybys prevent buses from obstructing bicycle lanes, maintaining clear cycling routes and minimizing conflicts with motor vehicles. This separation enhances cyclist safety and reduces bicycle lane misuse by passenger cars, particularly in congested areas where drivers might otherwise stop or park in cycling lanes. However, poorly designed bus laybys can introduce new risks, such as buses re-entering traffic unpredictably or unclear lane designations leading to misuse by other road users. The effectiveness of bus stop facilities in preventing bicycle lane obstruction depends on well-planned infrastructure that prioritizes the safety of all road users. While bus laybys can help mitigate bicycle lane misuse, their design and placement must be carefully considered to avoid unintended risks.

This study investigates the factors associated with the misuse of bicycle lanes by other road users. In this study, misuse refers to the use of bicycle lanes for riding, driving, walking, or parking by non-cyclists. Five explanatory variables are examined: the age and gender of other road users, the type of vehicle used, and two roadside features—street parking and the presence of bus laybys. The findings from this study will assist relevant agencies and local authorities in planning, designing, and developing future facilities to promote cycling. Additionally, the results can inform safety policies and awareness campaigns aimed at enhancing cyclist safety.

Although past studies have examined the effectiveness of bicycle lanes and general cyclist safety, limited attention has been given to the specific issue of bicycle lane misuse by non-cyclists in urban Malaysian settings. Existing research often focuses on infrastructure quality or crash outcomes, without analysing the behavioural and contextual factors that lead to encroachment by other road users. This study addresses that gap by investigating the demographic and environmental contributors to bicycle lane misuse across different road locations, based on direct field observations and logistic regression analysis. The findings are expected to support infrastructure development such as the design of protected intersections and placement of bus laybys, and to inform targeted policy measures and awareness campaigns aimed at reducing bicycle lane misuse and improving cyclist safety.

2. METHOD

2.1 Data Collection

This study was conducted in three Malaysian cities: Kuala Lumpur, Shah Alam, and Cyberjaya. These cities were selected for their distinct urban characteristics, active cycling communities, and local authorities' initiatives to promote cycling. Kuala Lumpur, home to 1.8 million residents in 2020 (DOSM, 2025), actively promotes cycling through workshops and seminars focused on eco-friendly transportation (DBKL, 2019). Shah Alam, with a population of 438,745 in 2024 (DOSM, 2025), provided valuable insights into cyclist behavior. Cyberjaya, located in the Sepang district and home to approximately 146,000 residents (SinarHarian, 2023), offers various active and passive sports and recreational facilities (Sarimin & Yigitcanlar, 2011).

In addition to population size and cycling initiatives, the selection of these cities considered factors such as infrastructure development, policy support, and visible cycling culture. Kuala Lumpur and ƒdedicated cycling infrastructure and road safety programmes, while Cyberjaya integrates active mobility within its smart city framework. All three cities feature predominantly delineated on-street bicycle lanes, although the level of enforcement and surrounding land use varies. This provided an opportunity to observe misuse patterns across different urban contexts while maintaining a focus on comparable lane types.

The observation was conducted over a nine-day period from 6 July to 14 July 2024. Data were collected during four daily time blocks representing both peak and non-peak hours: morning peak (7:00 AM to 9:00 AM), morning non-peak (10:00 AM to 11:00 AM), evening peak (5:00 PM to 7:00 PM), and evening non-peak (7:00 PM to 8:00 PM). These timeframes were selected to capture a range of traffic conditions and road user behaviours across weekdays and weekends.

A total of 15 observation points were established across the three cities, covering both intersections and midblock segments with varying traffic and infrastructure characteristics. To ensure consistency, all research assistants used a standardised observation form with clearly defined variables. Prior to data collection, assistants underwent a joint briefing and on-site training to ensure alignment in procedures and minimise discrepancies in judgement. Although formal inter-rater reliability testing was not conducted, periodic monitoring and coordination by the lead researcher helped reduce observer bias and maintain uniform data collection throughout the nine-day period.

Research assistants were appointed to monitor the misuse of bicycle lanes by other road users. Additionally, they recorded demographic and contextual factors, including gender, age, vehicle type, and the presence of a bus layby.

Observations were conducted at two types of road locations: midblock sections and intersections. Midblock locations were categorized based on the presence of bicycle lanes—either delineated by road markings or absent, where cyclists used the carriageway. Intersections included priority junctions and signalized junctions, each posing distinct challenges, such as turning maneuvers and merging behavior at roundabouts.

2.2 Data Analysis

After completing the data collection period, research assistants manually transferred data from paper-based forms into Excel spreadsheets, consolidating records from Kuala Lumpur, Cyberjaya, and Shah Alam into a master dataset. To ensure consistency, variables were standardized using uniform naming conventions and categorical coding. Data cleaning procedures included removing duplicates, addressing missing values through imputation or record removal, and verifying that all entries fell within valid ranges to ensure a reliable dataset for analysis.

Binary logistic regression models were developed to examine the misuse of bicycle lanes by other road users. The model incorporated explanatory variables related to demographic and contextual factors, including gender, age, vehicle type, and presence of a bus layby across two types of road locations. Binary logistic regression was selected to estimate the probability of binary outcomes based on these factors. This method applies to a logistic function to generate probability values between 0 and 1, making it well-suited for classification tasks with two possible outcomes in this study: no misuse (0) or misuse (1). Equation 1 presents the binary logistic regression model used in this study.

$$Z = \log(p/1\text{-}p) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \epsilon \qquad (1)$$

where Z is the logit (log-odds) of the probability p in binary logistic regression, p represents the probability of performing a misuse, $\frac{p}{1-p}$ represents the odds of risky interaction, $\log(\frac{p}{1-p})$ is the natural logarithm of the odds, also known as the logit, β_0 is the intercept term, β_1, β_2, β_3… are the coefficients corresponding to the predictor variables (gender, age, type of vehicle, and presence of bus layby) represented by X_1,X_2,X_3,, and ϵ is the error term.

3. RESULTS AND DISCUSSION

3.1 Descriptive Analysis

A total of 3,527 other road users, including pedestrians, motorcyclists, passenger car drivers, and heavy vehicle drivers, were observed during a nine-day survey conducted at two road locations, including midblock (1,639) and intersections (1,888). These observations were distributed across three cities: Kuala Lumpur (723), Shah Alam (723), and Cyberjaya (2,081). In all cities, a higher frequency of bicycle lane misuse was observed at intersections compared to midblock locations. Locations without bus laybys consistently recorded more misuse cases, particularly in Kuala Lumpur where signalised intersections showed frequent encroachment by passenger cars. These city-level patterns provide context for understanding spatial variation in misuse and highlight the influence of infrastructure design. The study focused on bicycle lane misuse by pedestrians, passenger cars, motorcycles, and heavy vehicles. Table 1 presents the number of misuse cases across both road locations. At midblock locations, roads with bicycle lanes recorded 699 misuse cases (42.6%). At intersections, priority junctions recorded 792 misuse cases (84.7%), while signalized junctions recorded 848 misuse cases (89.0%). It shows that signalised intersections represent the higher misuse cases compared to other locations. This pattern may reflect the challenge some road users face in accurately judging the lateral clearance between their vehicles and nearby cyclists, especially at signalised intersections where vehicle density and movement complexity are higher. Some variation was also observed between the three cities. In Kuala Lumpur, intersection misuse was more frequent, especially involving passenger cars at signalised junctions. Shah Alam recorded a relatively balanced distribution of misuse between midblock and intersection locations. In Cyberjaya, higher pedestrian misuse at midblock segments was noted. These trends may reflect differences in road layout, enforcement visibility, or the quality of bicycle lane infrastructure across the three cities.

Table 1. Misuse of Bicycle Lane by Other Road Users

Type of road	Misuse: No, N (%)	Misuse: Yes, N (%)	Total
Midblock			
Road with bicycle lane – delineated by road markings	940 (57.4)	699 (42.6%)	1,639
Intersection			
Priority junction (T-junction)	143 (15.3%)	792 (84.7%)	935
Signalized junction (T and cross junction)	105 (11.0%)	848 (89.0%)	953

Table 2 summarizes the explanatory variables based on bicycle lane misuse at midblock and intersection locations. The results indicate that female road users were more likely to misuse bicycle lanes at midblock locations (90.0%), while male road users had a higher misuse rate at intersections (88.4%). Young road users exhibited higher misuse rates along midblock sections (88.2%), whereas adults were more likely to misuse bicycle lanes at intersections (87.3%). Among different road user types, pedestrians showed the highest proportion of misuse within their own category, with 78.6% of observed pedestrians misusing the bicycle lanes. However, in terms of absolute numbers, passenger cars were the dominant road user type misusing bicycle lanes at intersections, with 91.7% of cars observed engaging in misuse. This distinction highlights the need to interpret proportions and total misuse counts separately. Locations without a bus layby showed higher misuse percentages for both midblock (92.1%) and intersection (90.5%) locations.

Table 2. Summary Statistics of Explanatory Variables

Variable	Misuse of bicycle lane by other road users at midblock		Misuse of bicycle lane by other road users at intersection	
	No (%)	Yes (%)	No (%)	Yes (%)
Other road user				
Gender				
Female	27(10.0)	242(90.0)	108(16.0)	568(84.0)
Male	672(49.1)	698(50.9)	140(11.6)	1072(88.4)
Age				
Young	16(11.8)	120(88.2)	24(19.8)	97(80.2)
Adult	683(45.4)	820(54.6)	224(12.7)	1543(87.3)
Type of users				
Pedestrian	251(21.4)	923(78.6)	74(23.5)	241(76.5)
Passenger car	280(99.3)	2(0.7)	97(8.3)	1069(91.7)
Motorcycle	168(91.8)	15(8.2)	60(19.7)	244(80.3)

Heavy Vehicle	-	-	17 (16.5%)	86 (83.5%)
Presence of bus layby				
No	55(7.9)	644(92.1)	140 (9.5)	1,332 (90.5)
Yes	926(98.5)	14(1.5)	108 (26.0)	308 (74.0)

3.2 Binary Regression Modelling

Table 3 presents the model estimation results for bicycle lane misuse at midblock locations, while Table 4 provides the results for intersections. Both models were analyzed based on demographic and contextual factors. For midblock locations, the Cox and Snell R^2 value of 0.646 and the Nagelkerke R^2 value of 0.868 indicate that the model explains between 64.6% and 86.8% of the variation in bicycle lane misuse. In contrast, for intersections, the Cox and Snell R^2 value of 0.060 and the Nagelkerke R^2 value of 0.111 suggest that the model accounts for only 6.0% to 11.1% of the variation. The relatively low Nagelkerke R^2 value for the intersection model (0.111) indicates limited explanatory power. This may be attributed to the exclusion of certain influential variables that were not captured during the observation period, such as real-time traffic volume, presence of enforcement officers, and specific intersection design features. These factors are likely to contribute to bicycle lane misuse at intersections and should be considered in future studies to improve model accuracy and explanatory strength. At midblock locations, gender and the presence of a bus layby were the only statistically significant predictors at a 95% confidence interval. For intersections, gender, vehicle type (passenger car), and presence of a bus layby were significant predictors. Although variables such as age and type of vehicle (e.g., motorcycle and heavy vehicle) were not statistically significant in this model, they were retained based on prior literature that recognises their potential influence on road user behaviour. Retaining these variables allows for consistency with existing studies and preserves the theoretical structure of the model. While removing them could result in a more parsimonious model, doing so may overlook important contextual or indirect effects not captured in the current dataset. The lack of significance may be due to limited variability in the observed sample or unmeasured factors such as traffic volume, enforcement presence, or road design characteristics. These variables may still hold practical relevance and should be examined in future studies with broader data inputs or expanded modelling approaches.

Table 3. Model Estimation of Bicycle Lane Misuse at Midblock

Variable	Reference	Odds Ratio	Confidence Interval (95%)	p-value
Gender				
Female	Male	5.409	2.175-13.453	0.001***
Age				
Young	Adult	0.817	0.402-1.660	0.576
Type of vehicle				
Passenger car	Pedestrian	0.326	0.059-1.812	0.200
Motorcycle		2.309	0.697-7.647	0.171
Presence of bus layby				

Yes	No	0.001	0.000-0.004	0.001***
Log likelihood		533.191		
Cox & Snell R^2		0.646		
Nagelkerke R^2		0.868		

*significant at 0.05 level,
**significant at 0.01 level,
***significant at 0.001 level

3.2.1 Gender

The model indicates that female drivers were more likely to misuse bicycle lanes than male drivers at both midblock and intersection locations, with odds ratios of 5.4 (95% CI: 2.175–13.453) and 2.1 (95% CI: 1.032–4.287), respectively. While these associations are statistically significant, the underlying behavioural explanation remains exploratory. Prior studies suggest that female drivers may respond more cautiously to high-conflict traffic environments due to heightened sensitivity to aggressive driving behaviour (Alonso et al., 2019; Lennon & Watson, 2012). This could lead to unintentional encroachment when avoiding perceived risks. However, this interpretation is based on general driving studies and not specific to bicycle lane misuse. Other possible contributing factors may include differences in driving exposure, route familiarity, or travel patterns in areas with bicycle infrastructure. These factors warrant further investigation in future research using more targeted data.

Table 4. Model Estimation of Bicycle Lane Misuse at Intersections

Variable	Reference	Odds Ratio	Confidence Interval (95%)	p-value
Gender				
Female	Male	2.104	1.032-4.287	0.041*
Age				
Young	Adult	0.766	0.451-1.302	0.325
Type of vehicle				
Passenger car	Pedestrian	2.741	1.887-3.981	0.001***
Motorcycle		1.189	0.785-1.801	0.413
Heavy Vehicle		1.428	0.772-2.641	0.256
Presence of bus layby				
Yes	No	0.340	0.254-0.457	0.001***
Log likelihood		1351.562[a]		
Cox & Snell R^2		0.060		
Nagelkerke R^2		0.111		

*significant at 0.05 level,
**significant at 0.01 level,
***significant at 0.001 level

3.2.2 Type of vehicle

Type of vehicle was not statistically significant at midblock locations. However, at intersections, it significantly influenced bicycle lane misuse. Compared to pedestrians, passenger cars were 2.74 times more likely to misuse bicycle lanes *(95% CI: 1.887–3.981)*, impacting the safety and efficiency of both motorized and non-motorized traffic. High traffic volumes at intersections increase risks for cyclists, and locations with extensive bicycle lane networks may still experience higher crash rates (Cai et al., 2021; Liu & Marker, 2020). In Addition, the transition from separated to mixed-traffic environments at intersections can also reduce driver awareness of cyclists, increasing the risk of conflicts (Deliali et al., 2021). Infrastructure design, particularly protected intersections, can help mitigate these risks by encouraging drivers to scan for cyclists and adjust their speed accordingly (Harris et al., 2013; Deliali et al., 2021). The interaction between passenger cars and cyclists at intersections highlights the need for improved infrastructure and greater public awareness to enhance road safety for all users. Although the statistical analysis identifies passenger cars as more likely to misuse bicycle lanes at intersections, the underlying behavioural motivations were not explored in this study. Possible factors include attempts to save time during turning manoeuvres, lack of awareness, or perceived absence of enforcement. These behaviours may be shaped by traffic conditions or design features that make encroachment more convenient or seemingly acceptable. Understanding these motivations would require more targeted behavioural data, and future research should consider incorporating qualitative or observational methods to explore these drivers more deeply.

3.2.3 Bus layby

The results indicate that bicycle lane misuse was significantly lower at midblock locations with a bus layby *(OR 0.001, 95% CI: 0.000–0.004)* compared to those without, and a similar trend was observed at intersections *(OR 0.340, 95% CI: 0.254–0.457)*. The presence of a bus layby reduces bicycle lane misuse by providing a designated space for buses to pull over, minimizing the likelihood of vehicles encroaching into the bicycle lane. Bus laybys allow buses to exit the main traffic flow, reducing their impact on bicycle lanes and limiting interactions between buses and cyclists (Zhang et al., 2018). While the presence of a bus layby was strongly associated with reduced bicycle lane misuse at midblock locations, the extremely low odds ratio (0.001) suggests that other factors may also be influencing this outcome. It is possible that locations with bus laybys also benefited from better road design, clearer markings, or lower traffic complexity. These elements were not recorded in this study, and their absence may limit the interpretation of the result. Future studies should consider including more detailed road design characteristics to better understand the true effect of bus laybys on misuse patterns. This separation of traffic helps maintain a clear path for cyclists, decreasing misuse and potential conflicts. The design of bus laybys not only preserves the integrity of bicycle lanes but also enhances safety by reducing conflicts between cyclists and other road users. Additionally, bus laybys contribute to more efficient traffic operations by preventing buses from blocking the bicycle lane, which could otherwise force cyclists to make unsafe maneuvers to bypass stationary buses.

4. CONCLUSION

This study analysed bicycle lane misuse by other road users, focusing on demographic and contextual factors. Field observations were conducted in three Malaysian cities, namely Kuala Lumpur, Cyberjaya, and Shah Alam, with a total of 3,527 observations recorded at midblock and intersection locations. Binary logistic regression was used to examine the relationship between bicycle lane misuse and variables such as gender, age, vehicle type, and the presence of a bus layby. The findings indicate that female road users were more likely than male road users to misuse bicycle lanes at both types of locations. Passenger cars were also significantly more likely to encroach into bicycle lanes compared to pedestrians. The presence of a bus layby was found to reduce misuse, suggesting that infrastructure characteristics can influence lane-sharing behaviours. These insights emphasise the importance of targeted awareness campaigns and behavioural interventions to address safety concerns for cyclists. In addition, infrastructure improvements such as protected intersections and appropriately placed bus laybys are recommended to support safer and more efficient road use. Although this study recommends such measures, their implementation must be adapted to the Malaysian road environment. Protected intersections may be more feasible in newly planned urban areas with flexible design options, while bus laybys can be prioritised at high-conflict zones. Future studies should explore the impact and practicality of these interventions through pilot applications and simulations. Although binary logistic regression was suitable for identifying significant predictors in this study, it may not fully capture complex relationships or interaction effects between variables. Future research may explore alternative or complementary approaches such as decision tree models or multilevel analysis to uncover deeper patterns related to bicycle lane misuse. Future research may also consider incorporating qualitative approaches or perceptual data to explore behavioural motivations, especially to better understand gender-related trends in bicycle lane misuse.

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REFERENCES

Alonso, F., Esteban, C., Montoro, L., & Serge, A. (2019). Conceptualization of aggressive driving behaviors through a Perception of aggressive driving scale (PAD). *Transportation Research Part F: Traffic Psychology and Behaviour*, *60*, 415–426. https://doi.org/https://doi.org/10.1016/j.trf.2018.10.032

Cai, Q., Abdel-Aty, M., & Castro, S. (2021). Explore effects of bicycle facilities and exposure on bicycle safety at intersections. *International Journal of Sustainable Transportation*, *15*(8), 592–603.

DBKL. (2019). *Kuala Lumpur Pedestrian and Cycling Masterplan 2019 - 2028*. Retrieved from https://www.dbkl.gov.my/wp-content/uploads/2023/08/2.-MASTERPLAN-KL-BIKE-PED-2019-2028.pdf

Deliali, K., Christofa, E., & Knodler Jr, M. (2021). The role of protected intersections in improving bicycle safety and driver right-turning behavior. *Accident Analysis & Prevention*, *159*, 106295.

DOSM. (2025). Kawasanku. Retrieved February 13, 2025, from Department of Statistics Malaysia, Malaysia website: https://open.dosm.gov.my/dashboard/kawasanku/W.P. Kuala Lumpur

ERSO. (2021). *Facts and Figures - Cyclists - 2021*.

Harris, M. A., Reynolds, C. C. O., Winters, M., Cripton, P. A., Shen, H., Chipman, M. L., …

Friedman, S. M. (2013). Comparing the effects of infrastructure on bicycling injury at intersections and non-intersections using a case–crossover design. *Injury Prevention*, *19*(5), 303–310.

Lennon, A., & Watson, B. (2012). Coping with aggressive driving: Driver accounts of how they manage themselves and others to reduce conflict on the road. *Proceedings of the 22nd Canadian Multidisciplinary Road Safety Conference*, 1–15. Canadian Association of Road Safety Professionals.

Liu, P., & Marker, S. (2020). Evaluation of contributory factors' effects on bicycle-car crash risk at signalized intersections. *Journal of Transportation Safety & Security*, *12*(1), 82–93.

Morrison, C. N., Thompson, J., Kondo, M. C., & Beck, B. (2019). On-road bicycle lane types, roadway characteristics, and risks for bicycle crashes. *Accident Analysis & Prevention*, *123*, 123–131. https://doi.org/https://doi.org/10.1016/j.aap.2018.11.017

Paschalidis, E., Oikonomou, A., Konstantinidou, M. N., Basbas, S., & Politis, I. (2023). The relationship of bicycle use and aggressive driving behaviour: a latent variable model approach. *Transportation Letters*, *15*(9), 1140–1153.

PLANMalaysia. (2013). Panduan Pelaksanaan Inisiatif Pembangunan Kejiranan Hijau. Retrieved from https://rehdaselangor.com/wp-content/uploads/3c.-Penyedian-Laluan-Basikal.pdf

Roslan, A., Zulkiffli, N. S. M., Jamil, H. M., Harun, N. Z., Jamaluddin, N., Hamidun, R., … Kassim, K. A. A. (2021). Evaluating the On-Street Bicycle Lane and Bicyclist Safety in Malaysia. *Journal of the Society of Automotive Engineers Malaysia*, *5*(4), 2–11.

Sarimin, M., & Yigitcanlar, T. (2011). Planning for knowledge based urban development in Malaysia: Cyberjaya@ Multimedia Super Corridor. *Summit Proceedings of the 4th Knowledge Cities World Summit*, 342–349.

Schultheiss, B., Goodman, D., Draper, J., & Blackburn, L. (2021). *On-Street Motor Vehicle Parking and the Bikeway Selection Process*. New Jersey.

SinarHarian. (2023, September 9). Cyberjaya mampu jadi lokasi pilihan pelaburan teknologi - PM. *Sinar Harian*. Retrieved from https://www.sinarharian.com.my/article/278074/bisnes/cyberjaya-mampu-jadi-lokasi-pilihan-pelaburan-teknologi---pm

Strohman, M. (2024). 2022 Bicycle Injury & Fatality Statistics (2024 Data): Cyclist Deaths On The Rise in the U.S.

Torrance, K., Sener, I., Machemehl, R., Hallett, I., Eluru, N., Hlavacek, I., & River, R. (2009). *The Effects of On-Street Parking on Cyclist Route Choice and the Operational Behavio of Cyclists and Motorists*. Texas.

WHO. (2023a). Despite Notable Progress, Road Safety Remains Urgent Global Issue.

WHO. (2023b). *Global Status Report on Road Safety 2023*. Switzerland.

Zhang, H., Qu, W., Ge, Y., Sun, X., & Zhang, K. (2017). Effect of personality traits, age and sex on aggressive driving: Psychometric adaptation of the Driver Aggression Indicators Scale in China. *Accident Analysis & Prevention*, *103*, 29–36.

Zhang, J., Li, Z., Zhang, F., Qi, Y., Zhou, W., Wang, Y., … Wang, W. (2018). Evaluating the impacts of bus stop design and bus dwelling on operations of multitype road users. *Journal of Advanced Transportation*, *2018*(1), 4702517.