https://doi.org/10.3311/PPtr.23326

Periodica Polytechnica Transportation Engineering, 52(3), pp. 310–316, 2024

Investigation of Traffic Issues at Unsignalized Taxila Intersection and their Countermeasures

Danish Farooq[1*], Rana Faisal Tufail[1], Muhammad Ali[1], Huzafa Iqbal[1], Abdul Rehman Tariq[1]

[1] Department of Civil Engineering, Faculty of Engineering, COMSATS University Islamabad, Wah Campus GT Road, P.O.B. 47040, Quaid Avenue, Wah Cantt, Rawalpindi, 47000 Punjab, Pakistan
[*] Corresponding author, e-mail: danish.farooq@ciitwah.edu.pk

Received: 30 August 2023, Accepted: 15 April 2024, Published online: 27 May 2024

Abstract

Taxila intersection is facing severe traffic issues includingcongestion, delays, increased travel times and inadequate infrastructure. The aim of the study is to highlight the real problems at Taxila intersection related to road users, vehicles and road infrastructure. Traffic data was collected during peak hours through traffic observing video cameras at the unsignalized intersection. Subsequently, traffic violation measurements and their comparisons between morning and evening peak hours, as well as between weekend and week days were developed. The study also identifies the involvement in traffic violations by different drivers, age groups and vehicle types. Comparing morning and evening peak hours reveals variations in traffic patterns and congestion levels throughout the day, helping to create customized plans. Similarly, investigating disparities between weekends and weekdays uncovers unique factors influencing traffic conditions on different days. Results showed that highest percentage of violations at the intersection resulted from 'illegal crossing of road by pedestrian' followed by 'illegal parking' at the intersection. While the lowest percentage of violation observed was 'wrong way driving' at the intersection. In conclusion, this research provides a comprehensive understanding of the traffic issues at the Taxila intersection and offers evidence-based strategies to improve traffic flow, mitigate congestion, and enhance road safety in the area.

Keywords

congestion, video analysis, violations, countermeasures

1 Introduction

Numerous studies have noted several factors that contribute to traffic congestion at urban intersections. According to Henning-Smith et al. (2017), insufficient road infrastructure with improperly designed intersections and inadequate capacity, can cause traffic bottlenecks. In addition, the incidence of conflicting traffic flows and insufficient signalization can intensify congestion (Jones et al., 2015). Traffic congestion is also instigated by ineffective road operations and by surplus demand (Kurzhanskiy and Varaiya, 2015). Population growth, land-use configurations, and variations in travel demand have also been observed as critical issues affecting traffic congestion (Li et al., 2016). Previous research examined the traffic concerns along the corridor, which comprise less than positive traffic movement, and an undesirable level of delays along with the environmental afflictions interpreted by noise and emissions stemming from the vehicles (Ali et al., 2015). Another case study examined an extremely congested intersection in Melbourne. The paper revealed several problems encountered in the analysis of congestion in application. The significance of utilizing demand flow data under congested circumstances and the effect of queue spillback in decreasing saturation flow rates were estimated in (Yumlu, et al., 2014).

In the lack of sufficient data, neither road operators nor travellers can measure how acutely the road system is functioning (Kurzhanskiy and Varaiya, 2015). Assessing traffic congestion level by means of social media data can deliver valued perceptions into traffic congestion levels, and the method displays capacity for real-time congestion observation and management (Liu et al., 2014).

Some preceding studies suggested the countermeasure to resolve the traffic problems at intersections. A study examined the safety effects of the unsignalized superstreet countermeasures on present arterials in North Carolina. The developments included traffic flow regulation, Empirical Bayes and comparison-group, analyses at unsignalized superstreet intersections. This showed substantial

Cite this article as: Farooq, D., Tufail, R. F., Ali, M., Iqbal, M., Tariq, A. R. (2024) "Investigation of Traffic Issues at Unsignalized Taxila Intersection and their Countermeasures", Periodica Polytechnica Transportation Engineering, 52(3), pp. 310–316. https://doi.org/10.3311/PPtr.23326

decline in total, as well as in the case of angle, right turn, and left turn collisions in all analyses (Ott et al., 2012).

Another study demonstrated that well-staged departure and proper application of traffic management at intersections are recommended, which subsidies to wide distribution of traffic flow and then high-efficiency exclusion (Fu, et al., 2015). Furthermore, a paper indicated its analyses on specificity of road traffic, analysis of spatial conflict point creation and pedestrian flow connections (Kapsky and Pegin 2015). Moreover, research was performed on Plane Intersection routing in traffic congestion region. In order to enhance the capacity of the plane intersection in such regions, this paper recommended solutions the intersection expansion method in the light of exit ramp expansion, entrance lane expansion, equivalent relation of entrance lane and exit ramp and turning ramp scheme etc. and also recommended the optimal design technique for the traffic (Fan et al., 2013).

Traffic Analysis was conducted on Taxila unsignalized intersection (N-5 Corridor Rawalpindi, Pakistan). The location of investigated area is shown in Fig. 1. It showed that there are so many conflict points for traffic moving in different direction. Drivers encountered problems while turning from one direction to other. In addition, the National Highway 05 or the N-5 is Pakistan's longest highway extending from the port city of Karachi to the border crossing at Torkham. Its total length is 1,756 km. This study highlighted difficulties that the road users face on a constant basis while traversing the chosen intersection. This study also includes the identification of measures to mitigate the current predicaments of congestion along the intersection.

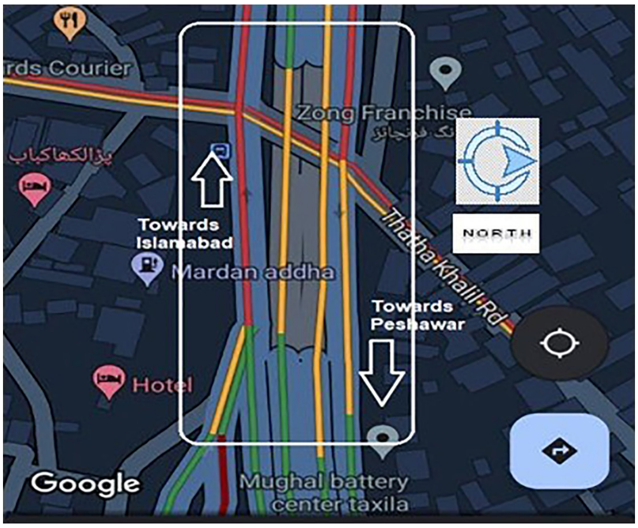

Fig. 1 Location of project

Furthermore, bus stops, rickshaw stands are not well designed at Taxila intersection. The actual width of the road is abridged by illegal parking and vendors marketing. It generally consists of mixed transport vehicles as shown in Fig. 2. All this leads to a poor traffic condition at this intersection. The heavy traffic from Hattar industrial estate and some cement factories deteriorates the condition. The plenty of private vehicles has a large share to play in this congestion in addition to heavy traffic. The most evident result of this congestion is the growth in travel time, mainly during peak hours. These factors not only disturb the flow of traffic but ultimately also affect economy and human health.

2 Objectives

This study investigated the major issues at the unsignalized Taxila intersection with the following objectives:

- Identify the key factors contributing to traffic issues at Taxila intersection.
- Analyse driver and pedestrian behaviour and its impact on traffic conditions.
- Comparison of traffic violations between weekdays and weekend, and between daytime and evening peak hours.
- Propose countermeasures to alleviate congestion and improve traffic management.
- Propose enhancement of road capacity to accommodate the growing number of vehicles.

3 Methodology

Traffic data collected during peak hours include traffic volume, vehicle types and driver/pedestrian behaviour, and their involvement in traffic violations through some sources such as traffic surveys, video analysis and interviews with traffic officials. In addition, we conducted on-site assessments of the identified intersection to evaluate its geometric design, lane configurations, and pedestrian facilities. All related steps are mentioned in the methodology overview chart as shown in Fig. 3.

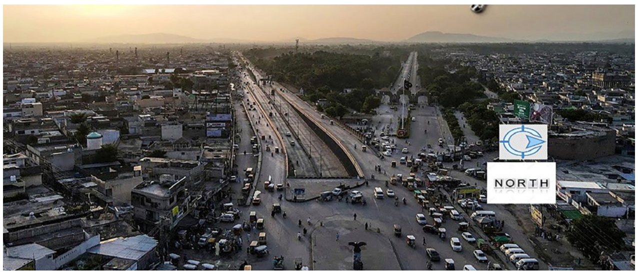

Fig. 2 Traffic congestion situation at Taxila intersection (overview)

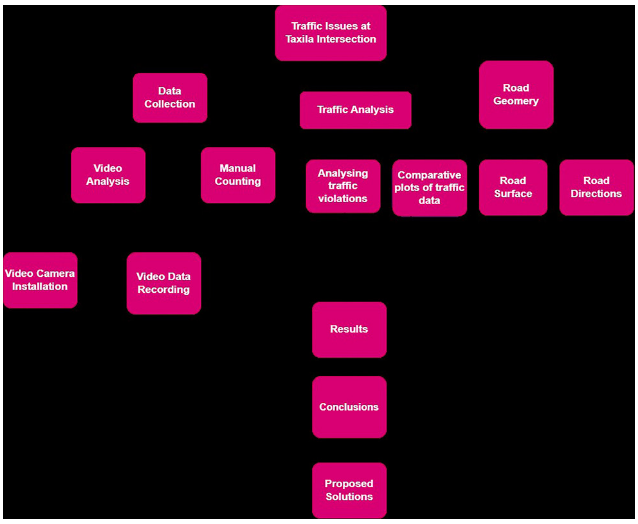

Fig. 3 Methodology

3.1 Video analysis

Video analysis provides a visual perspective that allows for a detailed examination of traffic patterns and behaviours, facilitating the development of targeted countermeasures to improve traffic management and road safety (Tsuboi, 2021). We installed traffic surveillance video cameras at all specified directions and recorded real-time footage at Taxila intersection. Traffic surveillance cameras were installed during the period from Oct 2022 to Dec 2022, and the exact time intervals of recording were 6 am to 9 am and 2 pm to 5 pm because that are the peak hour times.

Then from the video analysis, we counted each violation manually. We considered the time of the year because in the selected period, all the universities and the schools and offices remained open and weather condition was almost normal (mostly sunny with average temperature 20–30 °C). This method enabled us to observe the traffic patterns, identification of bottlenecks, and understand the primary causes of congestion at the Taxila intersection.

3.2 Traffic analysis

The collected data was analysed to identify the traffic trends, types of violations and factors involved, which cause traffic congestion. Traffic engineering techniques were also utilized to assess the lane configuration and road surface issues of the road network.

4 Results and discussions

After the collection of traffic data for each road segment of the intersection; Flow rate, Maximum Service flow rate, Capacity, volume to capacity ratio and Level of Service (LOS) were calculated in the related study (Farooq and Akram 2018). Results showed that LOS of intersection in morning and evening peak hours was 'E' and 'F', which means poor performance as described in Table 1 and Table 2.

Understanding the traffic patterns can help in identifying peak hours' traffic flow, managing traffic effectively, and implementing targeted strategies to address congestion and improve traffic flow in Taxila during weekends. These results provided insights about the distribution of traffic violations during different time intervals on weekdays and weekends. Fig. 4 illustrates that the highest number of violations occurred on weekday evenings (350) followed by weekend daytime (285).

Further analysis results from video analysis found the frequent types of violations at the intersection such as illegal crossing of road by pedestrian, illegal parking, overspeeding vehicles, illegal overtaking, frequent lane changing and wrong-way driving at the intersection. From these observed violations, results showed that the highest percentage of violations at the intersection resulted from 'illegal crossing of road by pedestrian' followed by 'illegal

Table 1 LOS of the intersection in the morning (Farooq et al., 2018)

Towards Intersection				From Intersection			
PHF	MSF	V/C	LOS	PHF	MSF	V/C	LOS
0.98	4448	0.71	C	0.87	5496	0.98	E

Table 2 LOS of the intersection in the evening (Farooq et al., 2018)

Towards Intersection				From Intersection			
PHF	MSF	V/C	LOS	PHF	MSF	V/C	LOS
0.90	6060	1.05	F	0.88	7764	1.3	F

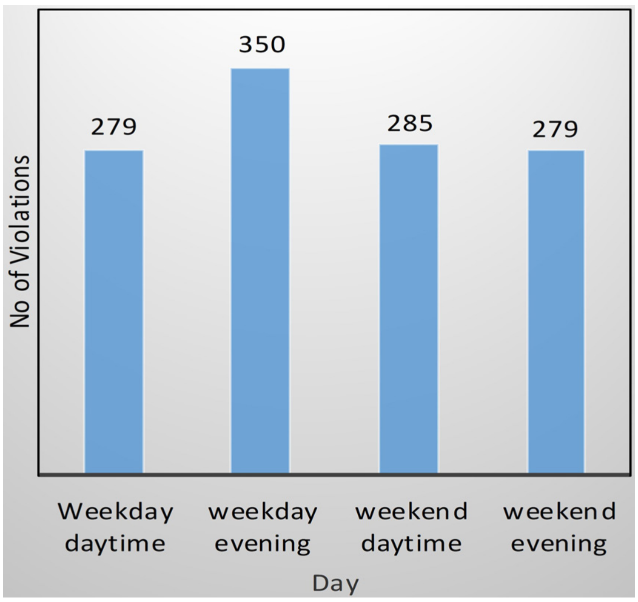

Fig. 4 Comparison between weekdays and weekends

parking' alongside different connecting roads at the intersection. While the lowest percentage violation is 'wrong way driving' at the intersection as shown in Fig. 5.

Violations by vehicle types were also observed from video analysis as number of violations. Results showed the highest number of violations by 'Auto Rickshaws' followed by 'Motorcycles'. While the lowest number of violations observed were committed by 'multi axle vehicles' as shown in Fig. 6.

To verify our data, a column chart (Fig. 7) is added for illustrating the number of different vehicle types on the roads of the whole country during different periods

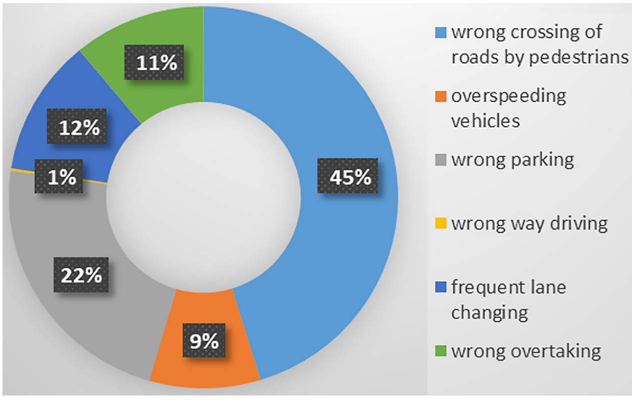

Fig. 5 Graph of percentage of violations

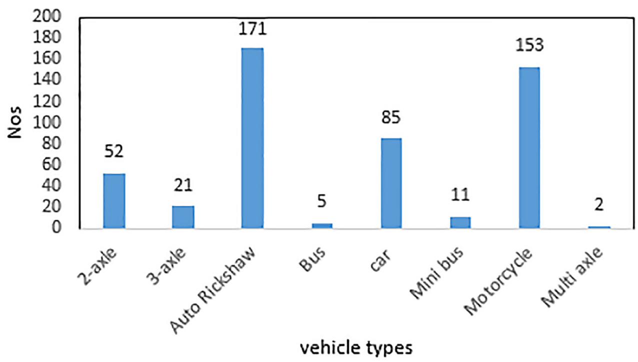

Fig. 6 Number of violations by vehicle types

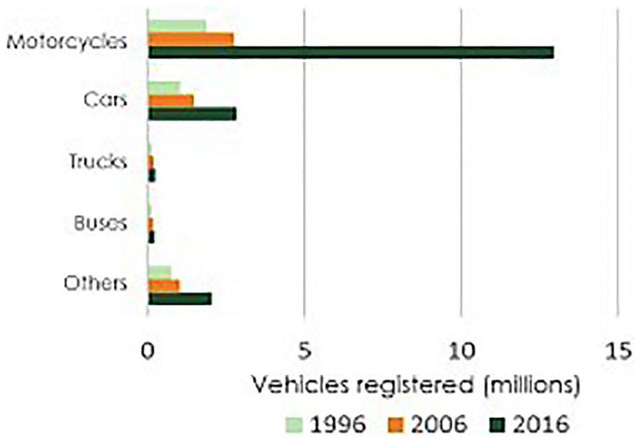

Fig. 7 Vehicle types growth in Pakistan

of time (most recent period was 2016), this shows similar numbers (high/low) for vehicle types which were involved in violations (Fig. 6).

4.1 Illegal crossing by pedestrians

The percentage by age groups was measured for the most frequent violation type 'illegal crossing' (Fig. 8). The age of pedestrians committing the illegal crossing was estimated from the video analysis. Results showed the highest percentage of 'illegal crossing' for age group '25–44' followed by age group '45–64'. The lowest percentage of 'illegal crossing' is observed for age group '0–9' followed by age group '65+' as shown in Fig. 9.

4.2 Illegal rickshaw stands

Illegal rickshaw stands exacerbate congestion on the roads. They cause traffic snarls and lead to increased travel time for vehicles. The presence of illegal rickshaw stands disrupts the flow of vehicles. They hinder pedestrian movement, making it difficult for people to navigate the area as shown in Figure 10.

4.3 U turns violations

Bikers do not follow designated lanes and often turn from any available space to avoid traffic, which can lead to accidents. Bikers tend to manoeuvre without using designated U-turn points and instead turn from wherever they find a passage.

Fig. 8 Illegal crossing by pedestrians

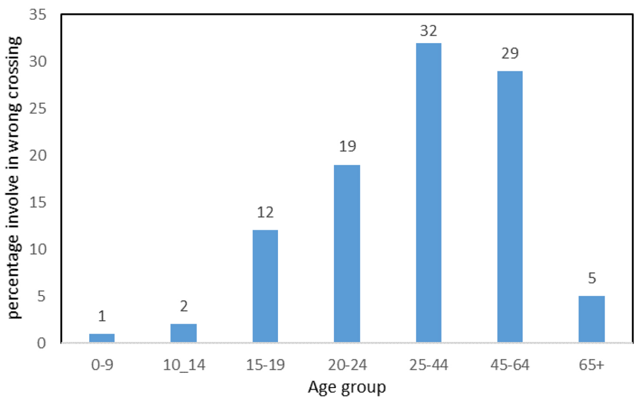

Fig. 9 Percentage involved in illegal crossing by age groups

Fig. 10 Illegal parking violation in the study area

Car drivers frequently change lanes and overtake each other whenever there is an opportunity as shown in Fig. 11.

4.4 Turning radius is less than standard

General recommendations for minimum turning radius:

- Urban roads (design speed of 30–40 km/h): 7–10 m
- Rural roads (design speed of 60–80 km/h): 20–30 m.

At Taxila interchange:

- Width of the road towards Peshawar main road: 5.79 m
- Disturbance caused by rickshaws, fruit carts, etc.: 1.8 m
- Width of the road towards Rawalpindi road: 4 m
- Disturbance caused by various factors: 2.16 m.

With the current disturbances (Fig. 12), it is difficult to achieve standard turning radius.

Fig. 12 Turning radius is less than standard

4.5 Road surface issues

Through image analysis, it was observed that there are critical road surface issues at the intersection such as edge failure, potholes, rutting and aggregate segregation as shown in Fig. 13. These road issues slow down the vehicular movement and increase congestion.

Fig. 13 Road surface issues

5 Countermeasures

Researchers have offered numerous traffic management approaches to lessen congestion at urban intersections. One frequently recommended approach is the application of intelligent transportation systems (ITS) (Wang et al., 2019). These systems utilize advanced technologies such as real-time traffic monitoring, dynamic route guidance and adaptive signal control to optimize traffic flow. Furthermore, road network modifications, including the facility of additional lanes and the building bypasses, have proven effective in alleviating congestion at busy intersections (Wang et al., 2018).

Fig. 11 U-turn violation

Engaging the community and involving stakeholders in the decision-making process can foster effective traffic management initiatives. Public participation in identifying traffic issues and proposing solutions can lead to better outcomes (Kathryn, 2014). Collaborative efforts between local government authorities, transportation agencies, and community organizations can help establish comprehensive traffic management plans that address the specific needs of studied intersection (Huang et al., 2019).

Integrated evaluation using simulation models to assess the impacts of congestion pricing policies is another major area of research. Congestion pricing can effectively reduce traffic congestion and improve traffic flow, but the effectiveness depends on factors such as pricing levels, exemptions, and implementation strategies (Ahuja and Lam, 2013).

Traffic congestion at the Taxila Interchange can be a challenging issue, and there are several possible solutions that can be implemented to improve traffic flow and reduce delays. Here are some proposed solutions that can be considered:

Road Surface Issues: For this issue the roads should be designed according to the required load bearing capacity and the material should be chosen accordingly.

Illegal crossing by pedestrians: Building overhead bridge for pedestrian crossing can reduce illegal crossing issues and improve traffic flow.

U Turn violations: to counter this issue, the traffic police officer should take strict actions against the culprits and heavy fines should be imposed on them and the government should launch a campaign to educate the people.

Illegal Rickshaw and bus parking: to counter this issue new rickshaw stands and bus parking areas should be built before and after the intersection. So that the congestion on the intersection should be minimized.

Turning Radius Issue: In this intersection, it seems that traffic barriers were placed to control movement of vehicles. These barriers can be placed bit wider to increase the turning radius. Also, heavy vehicles can be directed towards U-turn ahead (already available nearby) to change their direction.

Some other related solutions are discussed below.

- Adding more lanes: Adding more lanes to the Taxila interchange can help increase the capacity of the road and reduce congestion. This can be done by widening the existing lanes or adding new lanes to the interchange by removing illegal parking and vendors marketing.
- Improving public transportation: Encouraging the use of public transportation can help reduce the number of private vehicles on the road, which can help reduce congestion at the interchange. This can be done by improving the availability and frequency of public transportation options in the area.
- Implementing traffic management systems: Traffic management systems such as traffic signals, roundabouts, and other intersection improvements can help improve traffic flow and reduce congestion at the interchange.
- Implementing smart traffic management solutions: Smart traffic management solutions such as intelligent transportation systems (ITS), which use sensors and real-time data to manage traffic flow, can help optimize traffic management at the interchange.
- Alternative routes for heavy vehicles can reduce long delays at Taxila intersection.

6 Conclusions

Based on the investigated traffic issues, the following conclusions have been made:

1. The investigation of traffic issues at Taxila intersections has identified key factors contributing to congestion: illegal crossing by pedestrians, illegal parking, illegal overtaking, frequent lane changing, and other related factors.
2. Video analysis, peak-hour traffic data collection, traffic violation graphs, and comparisons between different time frames and days were conducted to gather valuable insights.
3. Countermeasures should include improved road signage, stricter enforcement of traffic regulations, and public awareness campaigns.
4. Modifying road geometry and enhancing infrastructure are crucial for alleviating congestion and ensuring safer traffic flow.
5. The investigation's findings serve as a resource for authorities, planners, and policymakers, guiding effective decision-making.

References

Ahuja R. K., Orlin J. B., Pallottino, S., Scutella M. G. (2003) "Dynamic shortest paths minimizing travel times and costs", Networks: An International Journal, 41(4), pp. 197–205. https://doi.org/10.1002/net.10072

Ali, N. M., Ali, A., Raza, S., Munir, R. J. (2015) "Traffic analysis: case study (N-5 Corridor Rawalpindi, Pakistan)", European Academic Research, 3(4), [online] Available at: https://api.semanticscholar.org/CorpusID:204769333 [Accessed: 14 April 2024]

Fan, H.-Q., Jia, B., Li, X.-G., Tian, J.-F., Yan, X.-D. (2013) "Characteristics of traffic flow at nonsignalized T-shaped intersection with U-turn movements", The Scientific World Journal, 2013, 856416. https://doi.org/10.1155/2013/856416

Farooq, D., Akram, T. (2018) "Traffic flow analysis and solutions to ease traffic flow at unsignalized taxila intersection", Periodica Polytechnica Transportation Engineering, 46(2), pp. 101–107. https://doi.org/10.3311/PPtr.10415

Fu, H., Pel, A. J., Hoogendoorn, S. P. (2015) "Optimization of evacuation traffic management with intersection control constraints", IEEE Transactions on Intelligent Transportation Systems, 16(1), pp. 376–386.
https://doi.org/10.1109/TITS.2014.2336266

Henning-Smith, C., Evenson, A., Corbett, A., Kozhimannil, K., Moscovice, I. (2017) "Rural transportation: challenges and opportunities", Minneapolis, MN: University of Minnesota Rural Health Research Center [online] Available at: https://www.ruralhealthresearch.org/publications/1144 [Accessed: 03 November 2023]

Huang, Z., Xia, J., Li, F., Li, Z., Li, Q. (2019) "A peak traffic congestion prediction method based on bus driving time", Entropy, 21(7) p. 709.
https://doi.org/10.3390/e21070709

Jones, S., Tefe, M., Appiah-Opoku S. (2015) "Incorporating stakeholder input into transport project selection – a step towards urban prosperity in developing countries?", Habitat International, 45, pp. 20–28.
https://doi.org/10.1016/j.habitatint.2014.06.017

Kapsky, D. V., Pegin, P. A. (2015) "Accident prediction methodology using conflict zone method for "transit transport – pedestrian" conflict situation and models of traffic flows at controlled intersection", Science and Technique, 5, pp. 46–52. [online] Available at: https://sat.bntu.by/jour/article/view/869?locale=en_US [Accessed: 14 April 2024]

Kathryn, S. Q. (2014) "Public participation in transportation planning", In Encyclopedia of Transportation: Social Science and Policy, edited by Mark Garrett, Thousand Oaks, CA: Sage Publications, Minneapolis, USA, pp. 1132–1137. [online] Available at: https://www.academia.edu/2980753/Public_Participation_in_transportation [Accessed: 14 April 2024]

Kurzhanskiy, A. A., Varaiya, P. (2015) "Traffic management: an outlook", Economics of Transportation, 4(3), pp. 135–146.
https://doi.org/10.1016/j.ecotra.2015.03.002

Li, Z., Liang, C., Hong, Y., Zhang, Z. (2016) "How do on-demand ride-sharing services affect traffic congestion? The moderating role of urban compactness", Production and Operations Management, 31, pp. 1–21.
https://doi.org/10.2139/ssrn.2838043

Liu, Y., Feng, X., Wang, Q., Zhang, H., Wang, X. (2014) "Prediction of urban road congestion using a Bayesian network approach", Procedia – Social and Behavioral Sciences, 138, pp. 671–678.
https://doi.org/10.1016/j.sbspro.2014.07.259

Ott, S. E., Haley, R. L., Hummer, J. E., Foyle, R. S., Cunningham, C. M. (2012) "Safety effects of unsignalized superstreets in North Carolina", Accident Analysis and Prevention, 45, pp. 572–579.
https://doi.org/10.1016/j.aap.2011.09.010

Tsuboi, T. (2021) "Traffic flow analysis and management", Sepasgozar, S., Shirowzhan, S., Sargolzae, S., and David Bienvenido-Huertas, J. (eds.). (2021) Design of Cities and Buildings – Sustainability and Resilience in the Built Environment, IntechOpen, pp. 1–16. ISBN: 978-1-78985-150-2
https://doi.org/10.5772/intechopen.95087

Wang, X., Xu, L., Hao, Y. (2019) "What factors predict drivers' self-reported lane change violation behavior at urban intersections? A study in China", PloS One, 14(5), e0216751.
https://doi.org/10.1371/journal.pone.0216751

Wang, Y., Szeto, W. Y., Han, K., Friesz, T. L. (2018) "Dynamic traffic assignment: a review of the methodological advances for environmentally sustainable road transportation applications", Transportation Research Part B: Methodological, 111, pp. 370–394.
https://doi.org/10.1016/j.trb.2018.03.011

Yumlu, C., Moridpour, S., Akcelik, R. (2014) "Measuring and accessing traffic congestion: a Case Study", Paper presented at the AITPM, National Conference, Adelaide, Australia, pp. 1–10. [online] Available at: https://researchrepository.rmit.edu.au/esploro/outputs/9921859981501341 [Accessed: 14 April 2024]