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Feasibility Study of a Motorcycle Lane: Evaluation of Travel Time and Delay Impacts at New Baneshwor Intersection

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Abstract

Like many South Asian countries, Nepal can be identified as a "Motorcycle Dependent Country" as the chief mode of transportation on the urban streets of Nepal compromises of Motorcycles for their daily commute. With inefficient public transportation, haphazard lane discipline, and easy accessibility and mobility of PTW, there is a rising dependence on PTW. The risk of life that comes with this dependence is also increasing in the urban streets of the country. Therefore, this research proposes Motorcycle Lanes as a measure to reduce congestion and create a risk-free riding environment. Three scenarios– a) Considering Dedicated motorcycle lanes b) Excluding right turning traffic into dedicated motorcycle lanes c) Dedicated motorcycle lanes only for two intersection legs Maitighar-Tinkune and Tinkune-Maitighar have been proposed, analyzed and compared with base data to measure the efficiency of motorcycle lanes at the New-Baneshwor intersection. The feasibility of those scenarios was checked based on traffic volume, Q-length, and vehicle delay with base data obtained from simulation in VISSIM. It was observed that difficult turning movements, unpredictable riding behavior and signal phases rendered the lanes unfeasible. A need for a holistic approach to address current and future traffic conditions as PTW are poised to experience a high upswing in foreseeable future is an essence.

Keywords: Intersection, Motorcycle Lane, VISSIM, PTW, Urban Mobility

1. Introduction

1.1 Background

Nepal, like many other South Asian countries, heavily relies on motorcycles as the primary mode of transportation, particularly in urban areas. According to the Department of Transport Management (DoTM), out of the total registered vehicles in Nepal, motorcycles make up a significant portion, with 249,581 motorcycles recorded in the fiscal year 2075/76 (2018/19). Among the major cities in Nepal, Kathmandu has the highest population and faces hazardous traffic conditions, primarily due to the dominance of motorcycles on its urban streets. Furthermore, several papers have shown that the percentage share of motorcycles is more than 75%, this has led to Kathmandu being referred to as a "Motorcycle Dependent City" in Nepal.

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The high dependence on motorcycles is caused by several factors like high-density urban areas, lack of roads and parking facilities, poor public transportation in the city, etc. Along with these factors, the high accessibility and mobility of motorcycles is also the prime cause behind motorcycle dependence in Nepal. Since many families in Nepal are still at low-middle level income they can support their motorcycle ownership easily. Therefore, it can be said that there is the domination of PTW in the country and more specifically on the urban streets of Kathmandu.

In a city where the volume of engine displacement has become a status symbol among the youths has contributed to increasing motorcycle dependency throughout the country and resulted in unsustainable transport in the city. The major problems that arise due to the rise in PTW dependence are increased road crashes, congestion, and pollution. Even though these may be a threat the more serious concern is the immaturity of the society that promotes bad road user behavior, lane indiscipline, and lack of awareness in the urban streets of Kathmandu.

With PTW dominating the traffic flow of Kathmandu, they are responsible for reducing the capacity of the roads and reducing the saturated flow in a signalized intersection. Urban mobility in the case of Kathmandu Valley is hectic due to haphazard lane discipline, irresponsible road-user behavior, and an increasing amount of traffic. The limited transport infrastructure like space for roads, parking, and inefficient public transportation facilities of Kathmandu Valley creates a devastating situation for the local commuters. It has been identified that the main cause of the problem that exist in the area of New-Baneshwor intersection is due to heavy traffic volumes which exceed the capacity. (Shrestha & Marsani, 2017).

To simulate the real-life traffic flow of road users at intersections, a microscopic multimodal traffic flow simulation software PTV VISSIM (Verkehr in Städten - SIMulationsmodell) is used. Delays on intersections and travel time are calculated before and after the introduction of the motorcycle lane by running simulations on VISSIM and later efficiency and usefulness of the motorcycle lane are evaluated based on a comparison between the data obtained.

1.2. Research Objectives

The objective of this research is to study the impact of proposed motorcycle lane on travel time and delay at New Baneshwor intersection under different scenarios.

2. Literature Review

Motorcycle is a major mode of transportation in economically backward nations, especially in Asia. The high rate of motorcycle ownership is because it is the most affordable mode of transportation available and also helps to support the socio-economic activity of the user but the rapid increase in this number also causes traffic congestion, air pollution, and increased accident rates (Putranto, et al., 2011)

Motorcycle lanes in general can be understood as the segregation of all the powered two-wheelers (PTW) from the rest of the traffic. The first exclusive motorcycle lane in the world was constructed along the Federal Highway Route 2 in the state of Selangor, Malaysia. Lane widths of 2.0m (6.6ft), 2.5m (8.25ft), and 3.0m (9.9ft) were recommended for motorcycle volumes ranging from 1000-1500, 1500-2000, and above 2000 per hour respectively. (Hussain, et al., n.d.)

Inclusive motorcycle lanes are developed within an existing carriageway which is sited on the left side of the road. Motorcyclists are encouraged to use this section of the road while riding. Physical barriers and pavement markings define the road section set aside for motorcyclists. But at crossings and intersections, it ceases as an exclusive lane and conflicts may be seen with other vehicles. (Yusof, 2011)

An exclusive lane is established for the sole use of motorcyclists and separates from other traffic exclusively. All motorcycles are required to use it by law and other vehicles are prohibited from entry. Segregation of motorcycles from other traffic significantly reduces speed differential problems as long as they remain disassociated from the main carriageway. The analysis also suggests that segregation by means of exclusive motorcycle lanes provides one of the best ways to provide safety for powered two-wheelers along routes with most stakeholders being motorcycles. This measure also creates a healthier driving environment for motorcyclists along with other road users. (Radin Umar, et al., 1995)

Non-exclusive motorcycle lanes without any presence of physical separators were found to reduce the crash risk of motorcycles by as much as 83%. And the usage of this facility is also high among motorcycle users which decreases the crash risk against other vehicles by increasing separation between motorcycles and other traffic. This provision is considered if the benefits exceed, or equal costs sustained in comparison to safety associated with motorcycle users. The benefit is measured in terms of lives saved that is converted to monetary value termed as Value of Statistical Life (VOSL). The feasibility of the project can be considered if the ratio of VSOL with total accrued costs for providing the facility. VOSL is extensively used to estimate the burden of socio-economic losses incurred by a nation based on the gross domestic product per capita of people in that nation. (Poi, et al., 2019)

Segregation of the Motorcycle from the main traffic is found to be a beneficial strategy as it reduces the conflicts between a motorcyclist and another road user under heterogeneous complexities. It is also found to increase the motorcyclist's speed and creates a safer environment to travel. Thus, it is a temporary method of managing many PTWs. Since, there is no any hard and fast rule to create new physical infrastructures (except for some lane markings and lane barriers), so there is easiness in implementation. (Saini, et al., 2022)

The simulation inputs and outputs are compared with the GEH formula as per (Oregon Department of Transport, 2011). For hourly flows, the GEH formula is presented in the equation below:

$$GEH = \sqrt{\frac{2(m-c)^2}{m+c}}$$

Where,
m = output traffic volume from the simulation model (vph)
c = input traffic volume (vph)

$GEH < 5.0$	Acceptable fit
$5.0 \leq GEH \leq 10.0$	Caution: Possible model error or bad data
$GEH > 10.0$	Unacceptable

Since, there are no research conducted to study the feasibility of motorcycle lanes in Nepal, all possible attempt has been made to fill the gap in the existing literature. Along with other several research of Motorcycle lanes, its feasibility in Nepal, and the microsimulation using VISSIM, this study can be of great importance.

The calibrated parameters by (Acharya & Marsani, 2020) is presented in Table 1 and is taken as reference for the calibration of VISSIM at New-Baneshwor Intersection.

Table 1 Calibrated Driving Behavior Parameters

S.N.	Parameters	Calibrated Values
1	Look ahead distance-min	30 m
2	Look back distance-min	5.0 m
3	Average standstill distance	0.30 m
4	Additive part of safety distance	0.19
5	Multiplicative part of safety distance	0.71
6	Min. headway (front/rear)	0.50 m

3. Methodology

The methodological framework is presented in Figure 1. Field data such as intersection geometry, and signal timing was taken at the New-Baneshwor intersection. Video acquisition was done with the help of Kathmandu

Valley Police Office, Ranipokhari, Kathmandu. Traffic data of morning peak hour, i.e. 9:00 AM – 11:00 AM was used as input for simulating the model in VISSIM. Additional data were taken as required during the research period.

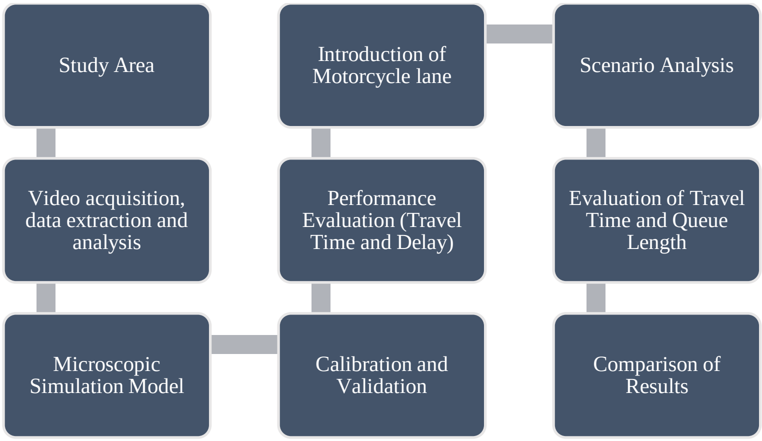

Figure 1 Framework of methodology

3.1. Study Area

Literature review was performed regarding the selection of study area. It has been found that for the introduction of motorcycle lane, signalized intersections with high motorcycle volume were selected. New Baneshwor intersection was found to satisfy the criteria and was selected as the study area for the research. The general layout of New Baneshwor Intersection is shown in *Figure 2*.

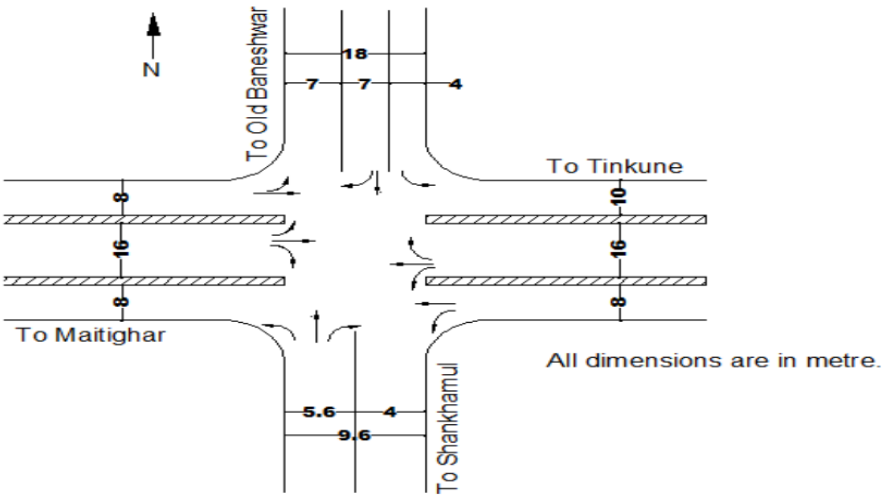

Figure 2 Geometry of New Baneshwor intersection (Sketch Not to Scale)

3.2. Video acquisition, data extraction and analysis

Traffic police CCTV footage was used to extract data manually for the New-Baneshwor intersection during morning peak hours i.e., 9:00 A.M. to 11:00 A.M. The classified volume counts was performed for 15-minute intervals. The recording was repeatedly played, and data were extracted by the team. The CCTV footage of 28th November 2022 Monday, 29th November 2022 Tuesday, 30th November, 2022 Wednesday and 1st December, 2022 Thursday was played and data were extracted at Kathmandu Valley Police Office, Ranipokhari.

. Along with classified volume count, the following data were also extracted from the CCTV footage:

- Vehicle type
- Directional movement of vehicle
- Signal timing

Motorcycle, Car, Bus, Micro, Tempo, Truck, Minitruck and pickup were only used to classify vehicle types and the rest were ignored as their frequency is relatively low or almost zero in some cases.

3.3. Microscopic simulation model

The aerial view of the New-Baneshwor intersection was extracted with the help of a virtual map tool i.e., Google Earth, and links and connector were used to represent the road segments. The basic element of VISSIM is called a link and represents a single or multiple-lane roadway with a specified flow direction. Connectors were used to join two links that created a network. Next, traffic controllers were used to define the turning movements in a signalized intersection. Appropriate coding of these traffic controlling devices was necessary to simulate the field condition. Then, classified traffic volume along with routing decisions based upon relative flows were fed into VISSIM for simulation.

3.4. Calibration and validation

Calibration of the model was performed for driving behavior and traffic volume. The data of three days were used as input for calibration. The validation of the model was done using the data of the fourth day.

3.5. Allocation of dedicated motorcycle lane

For our research, dedicated Motorcycle lanes were developed in the network model after calibration and validation of the base network model. Motorcycle lanes of width 3.5 m were allocated in the network model. No lanes were provided for Shankhamul lane as the lane existing geometry and infrastructure was insufficient to include a motorcycle lane without disturbing the normal flow and both turning movements. Outer lanes of Tinkune-Maitighar section were allocated as bike lanes. The flow of other vehicles was strictly restricted from entering in these motorcycle lanes by developing a separate links. The vehicle input of only motorcycles was entered in these lanes. Similarly, for Old-Baneshwor the extreme left lane for entering and middle lane for exiting the Old-Baneshwor segment was developed as motorcycle lanes. The location of proposed motorcycle lanes is shown in the Figure 3.

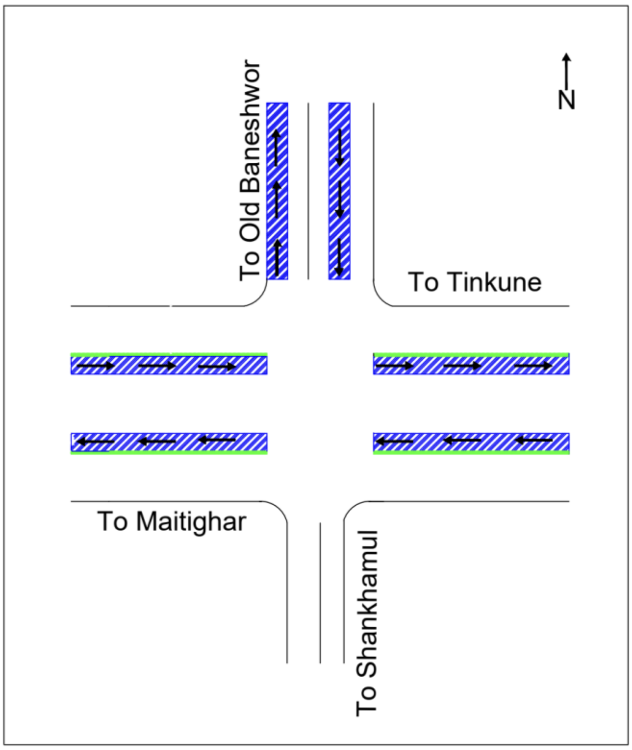

Figure 3 Proposed motorcycle lane

4. Data Analysis

4.1. Traffic volume at intersection

It was found out that the total volume at the intersection is 18,416.5 PCU during 9:00 A.M. to 11:00 A.M. on Monday. The total volume flowing from Tinkune is greater than other legs because major businesses as well as educational enterprises and commercial spaces are in Kupandole, Putalisadak, Ratnapark, New Road, etc. and people traverse the New Baneshwor section for reaching upto those commercial spaces.

4.2. Traffic composition

Motorcycles compromise most of the total traffic volume i.e., around 77% of the total traffic on Monday. The results were somehow similar on other days as well. The percentage ownership of privately owned vehicles has a large edge over public vehicles. The traffic volume from Old-Baneshwor is comparatively less than that of Maitighar and Tinkune as only Tempo and Nepal Yatayat use this leg for public transport. The situation is similar to Sankhamul as only microbus and tempo use this leg for public transport facilitation. The number of motorcycles is more in the Tinkune service lane compared to the minibus, this has developed due to the presence of big banks and educational institutes. The classified volume count on Monday at New Baneshwor Intersection is presented in Table 2.

Table 2 Classified volume count on Monday at New Baneshwor Intersection

Day: Monday									
Time	**Bike**	**Car**	**Pickup**	**Mini Truck**	**Truck**	**Bus**	**Tempo**	**PCU**	**Total**
9:00-9:15	2209	589	32	0	2	94	55	2068.5	2981
9:15-9:30	2503	612	13	0	12	93	35	2226.5	3268
9:30-9:45	2601	659	16	0	9	117	51	2404.5	3453

9:45-10:00	2805	612	17	0	11	112	39	2439.5	3596
10:00-10:15	2912	606	14	0	7	108	42	2463	3689
10:15-10:30	2598	589	11	0	6	98	35	2246	3337
10:30-10:45	2297	553	13	0	5	115	45	2119.5	3028
10:45-11:00	2660	689	17	0	5	121	50	2464	3542
Total	**20585**	**4909**	**133**	**0**	**57**	**853**	**352**		
Percentage	**76.55%**	**18.25%**	**0.49%**	**0%**	**0.21%**	**3.17%**	**1.31%**	**18416.5**	**26889**

4.3. Relative flow for static vehicle routing

Relative flow in each direction was calculated by dividing the total traffic moving in a particular direction by the total leg volume. For instance, the traffics from Maitighar main lane was divided into 3 segments: -

- To Old Baneshwor
- To Tinkune Service Lane
- To Tinkune Main Lane

And their percentage share was calculated.

4.4. Calibration and validation

Any model created in VISSIM needs to be calibrated first for the different parameters, which affect the behavior of the model. So, three days data were used as input for the calibration of the model so that the model represented the field condition. Among several VISSIM parameters those parameters which affected the model most were Look ahead distance, Look back distance, Average standstill distance, Additive part of safety distance, Multiplicative part of safety distance, and Min. Headway. (S M P & Ramadurai, 2013)

The values of these calibrated driving behavior parameters taken in our study are shown in Table 3.

Table 3 Calibrated driving behavior parameters

S.N.	Parameters	Calibrated Values
1	Look ahead distance-min	30 m
2	Look back distance-min	10.0 m
3	Average standstill distance	0.25 m
4	Additive part of safety distance	0.19
5	Multiplicative part of safety distance	0.70
6	Min. headway (front/rear)	0.50 m

On using GEH statistics, the GEH values were found to be less than 5 that indicated the acceptable fit of the model. Furthermore, the simulated traffic volume was compared with the actual field volume.

The Calibration of VISSIM Model for Traffic Volume for peak hour flow 9:00 A.M. to 11 A.M. is shown in Figure 4.

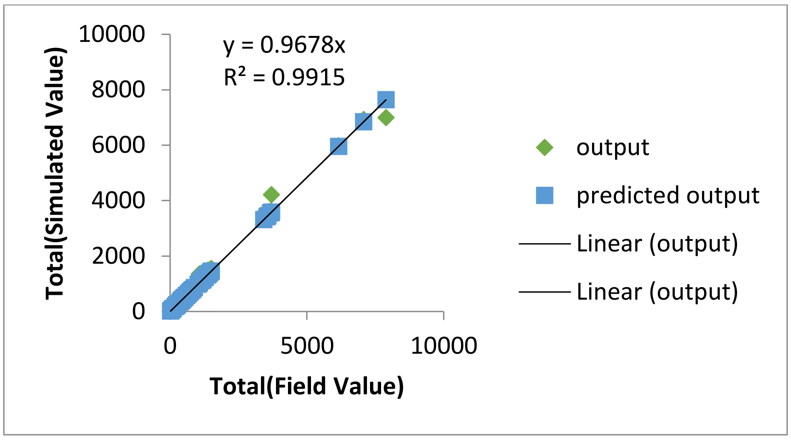

Figure 4 Calibration using three days data (9:00 A.M. – 11:00 A.M.)

R squared value after calibration was found to be 0.977 which indicated that 97.7 percent of variance of the field data is explained by the variance of the VISSIM output.

The Regression equation for this calibration is:

$$Expected\ Traffic\ Volume\ (VISSIM) = 0.9678 \times Actual\ Field\ Volume \quad \text{(Equation 1)}$$

The (Equation *1* is then used to find the Expected Traffic Volume for Monday. The obtained expected traffic volume was then compared with the traffic volume obtained after simulation was performed on VISSIM using data of Monday. Regression analysis was used to validate the model. The validation was done with a R^2 value of 0.995.

4.5. Scenario analysis

As an approach for traffic management, following alternatives are analyzed and evaluated to adopt the best one possible. Three different scenarios were proposed and the results of each scenario (total traffic volume, queue length, vehicle delay) were compared with the result obtained from the base model.

4.5.1. Scenario 1

The total volume of motorcycles with all possible routes was considered in the dedicated motorcycle lanes. For instance: Motorcycle flowing in Maitighar-Tinkune, Maitighar-Shankhamul, and Maitighar-Old Baneshwor were all considered in the motorcycle lanes and rest of vehicle types were allowed to flow in the normal lanes. The design was carried out considering the traffic volume of Tuesday and Thursday as input.

4.5.2. Scenario 2

After, the analysis of scenario 1, it was found that right turning motorcycles created distortion in the simulation. Motorcycles with right-turning movements were restricted on dedicated motorcycle lanes and their flow was made possible in the normal lanes. For instance: motorcycle with right turning movements i.e., Maitighar-Shankhamul were restricted to flow in the dedicated motorcycle lanes, and they were allowed to flow in the normal lane where other vehicle types would flow. The design was carried out considering the traffic volume of Tuesday and Thursday as input.

4.5.3. Scenario 3

The dedicated motorcycle lanes for Maitighar-Tinkune and Tinkune-Maitighar was only considered by excluding Old-Baneshwor motorcycle lanes as this motorcycle lane generated much of the conflict in the simulation and node results. The design was carried out considering the traffic volume of Tuesday and Thursday as input.

4.5.4. Comparison of scenarios

The output obtained by implementing each scenario into the model was compared with the base model for the selection of a suitable scenario for efficient urban mobility at New-Baneshwor intersection. The comparison of various scenarios has been presented in Table 4 and the graphical representation has been presented in Figure 5.

Table 4 Comparison of results from different scenarios with the base model

Day	Scenarios	Total Vehicles	Q-length max	Vehicle delay	Percentage Change		
					Total Vehicles	**Q-length max**	**Vehicle delay**
Tuesday	Base	25475	199.36	34.94861			
	Scenario 1	22145	255.742287	49.380734	-13.072	28.282	41.295
	Scenario 2	22795	264.398741	78.58949	-10.520	32.624	124.872
	Scenario 3	22258	264.39345	98.613898	-12.628	32.621	182.168
Thursday	Base	25434	263.102441	34.007125			
	Scenario 1	22621	255.878962	51.978696	-11.060	52.846	52.846
	Scenario 2	22621	264.39836	81.68172	-11.060	140.190	140.190
	Scenario 3	22294	264.39424	82.247721	-12.346	141.854	141.854

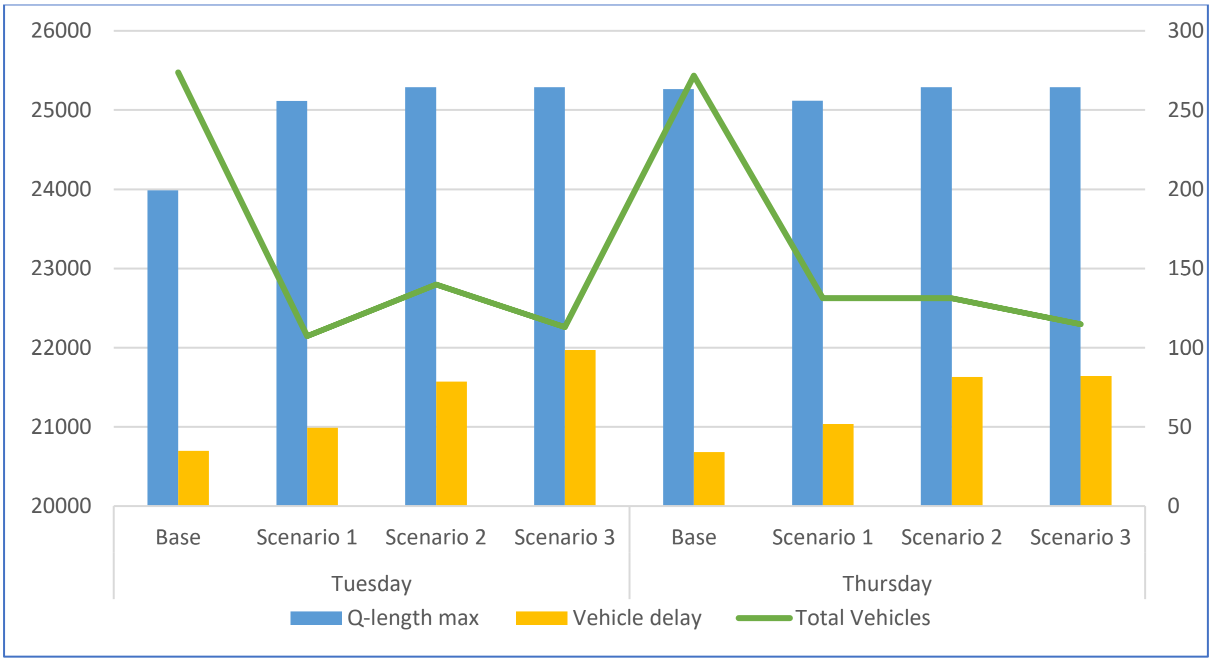

Figure 5 Comparison of results from different scenarios with the base model

Similarly, this comparison was also done in all traffic movement direction to check whether the dedicated motorcycle lanes with the above-mentioned scenarios improved the efficiency of urban mobility at intersections. The comparison of all scenarios with the possible movement is shown in Table 5.

Table 5 Comparison of results from different scenarios with the base model (direction considered)

Direction	Base	Scenario 1	Scenario 2	Scenario 3
Maitighar Service Lane to Tinkune Service Lane	432	462	462	482
Maitighar Service Lane to Tinkune Main Lane	53	0	0	0
Maitighar Service to Old Baneshwor Lane	303	326	326	306
Tinkune Main Lane to Maitighar Main Lane	6924	4875	6223	6617
Tinkune Main Lane to Maitighar Servic Lanee	115	81	62	0
Tinkune Main Lane to Old Baneshwor	3611	2547	2624	2491
Tinkune Main Lane to Sankhamul	12	10	15	0

Tinkune Service Lane to Maitighar Main Lane	483	0	0	0
Tinkune Service Lane to Maitighar Service Lane	1081	1395	1011	1312
Tinkune Service Lane to Sankhamul Lane	531	713	507	453
Old Baneshwor to Tinkune Service Lane	1175	1042	1042	1170
Old Baneshowr to Tinkune Main Lane	1149	1259	1259	0
Old Baneshwor to Maitighar Main Lane	889	958	958	845
Old Baneshwor to Maitighar Service Lane	208	39	39	213
Old Baneshwor to Sankhamul	1268	1321	1321	1249
Sankhamul to Tinkune Service Lane	123	123	123	156
Sankhamul to Tinkune Main Lane	310	310	310	390
Sankhamul to Maitighar Main Lane	548	546	545	0
Sankhamul to Maitighar Service Lane	507	507	505	641
Sankhamul to Old Baneshwor	1171	1169	1166	1459
Maitighar Main Lane to Tinkune Service Lane	267	272	254	0
Maitighar Main Lane to Tinkune Main Lane	3589	3487	3447	3697
Maitighar Main Lane to Old Baneshwor	235	272	275	273
Maitighar Main Lane to Sankhamul	491	431	420	487

In Table 4 and Table 5, the three scenarios proposed for the study period and time is compared with the base model that have been validated. The implementation of Motorcycle Lane for urban mobility and management of traffic at intersection is not found to be feasible when subjected to three scenarios.

5. Results and Discussion

The study highlights the remarkable resonance between the real-life scenario and simulated scenarios. A phenomenon largely substantiated by GEH parameter being within the acceptable range. The calibration and validation of the scenarios were within the permissible limits. The presence of difficult turning movements of the PTW, unpredictable riding behavior and complex signal phases led the application of motorcycle lanes faced with significant challenges and showcased impartibility due to loss of time for the passing of vehicles. Consequently, achievement of enhancements in traffic mobility and management at the intersection become subsequently challenging. In essence, introduction to a dedicated waiting zone for right turning movements holds a noteworthy potential to elevate the conflict zones and reduce congestion formation. While the lane geometry of the intersection is adequate for current traffic volume, Sankhamul and Old Baneshwor being equipped with constricting lanes especially Sankhamul lane has aided in congestion issue. Furthermore, the irregular riding pattern of motorcycles had further added challenges to our scenarios, underscoring a need for a holistic approach to address current and future traffic conditions as PTW are poised to experience a high upswing in foreseeable future.

References

Putranto, L. S. et al., 2011. The Performance of Motorcycle Lanes in Jakarta and Sragen. *Proceedings of the Eastern Asia Society for Transportation Studies,* Volume 8, pp. 290-290.

Yusof, M. R., 2011. *Speed-Density Relationship on Exclusive Motorcycle Lane Case Study of Federal Highway Route 2,* s.l.: s.n.

Radin Umar, R., Mackay, M. G. & Hills, B. L., 1995. Preliminary Analysis of Exclusive Motorcycle Lanes Along The Federal Highway F02, Shah Alam, Malyasia. *Journal of IATSS Research,* 19(2), pp. 93-98.

Poi, W. A. et al., 2019. *Motorcycle lane: how to judge if that is necessary.* s.l., IOP Publishing, pp. 1-10.

Saini, H. K., Chouchan, S. S. & Kathuria, A., 2022. Exclusive motorcycle lanes: A systematic review. *IATSS research,* October, 46(3), pp. 411-426.

Acharya, A. & Marsani, A., 2020. *Prediction of Traffic Conflicts at Signalized Intersection: A Case Study of New Baneshwor Intersection.* s.l., IOE Graduate Conference, pp. 996-1003.

S M P, S. & Ramadurai, G., 2013. Calibration of VISSIM for Indian Heterogeneous Traffic. *Procedia-Social and Behavioral Sciences,* Volume 104, pp. 380-389.

Oregon Department of Transport, 2011. *PROTOCOL FOR VISSIM SIMULATION,* s.l.: s.n.

Hussain, H., Radin Umar, R., Ahmad Farhan, M. & Dadang, M., n.d. *Key Components of a Motorcycle-Traffic System: A Study along the Motorcycle Path in Malaysia.* s.l., s.n.

Shrestha, S. & Marsani, A., 2017. Performance Improvement of a Signalized Intersection (A Case Study of New Baneshwor Intersection. *In Proceedings of IOE Graduate Conference,* pp. 1-8.