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Analyzing Vehicle-Pedestrian Conflicts at Satdobato Intersection

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Abstract

This study examines vehicle–pedestrian conflicts at the Satdobato signalized intersection in Lalitpur, Nepal, a critical urban node characterized by high-volume mixed traffic and high pedestrian activity. Utilizing primary data gathered via three-day video-based field surveys, the research captured peak-hour traffic volumes, pedestrian movements, and signal timings to develop a microscopic simulation model within VISSIM. Following calibration and validation against field conditions, conflict analysis was performed using the Surrogate Safety Assessment Model (SSAM), specifically employing Time to Collision (TTC) and Post Encroachment Time (PET) as primary indicators. The results reveal a high frequency of conflicts peaking at 2,680 incidents during the morning rush primarily driven by signal violations and inadequate pedestrian infrastructure. The study evaluates two mitigation strategies: redirecting pedestrians from Mahalaxmi lane to an existing overhead crossing, yielded a 13.88% reduction in conflicts; and construction of a new overhead crossing at Gwarko lane, achieved a more substantial 39.74% reduction. These findings demonstrate that targeted infrastructural interventions can significantly enhance intersection safety, though their efficacy remains contingent upon the specific operational characteristics of the diverse vehicle types present in the traffic stream.

Keywords: Vehicle-pedestrian conflicts, microsimulation, VISSIM, SSAM, traffic safety, Satdobato intersection

1. Introduction

1.1 Background

Urban intersections in rapidly developing cities like Kathmandu Valley are critical nodes where complex interactions between vehicles and pedestrians frequently lead to safety concerns. Traditional safety assessments relying on historical crash data are often insufficient due to the rarity of such events, necessitating a proactive approach using surrogate safety measures. The analysis of traffic conflicts observable events where a collision is imminent unless an evasive maneuver is performed has emerged as a robust methodology for identifying and quantifying safety risks before accidents occur.

Several studies have emphasized the importance of analyzing traffic conflicts at busy intersections. For example, Acharya and Marsani conducted a case study at New Baneshwor intersection, predicting traffic conflicts at a signalized junction [1]. Similarly, Muleya, Ghanimb and Kharbech applied the Surrogate Safety Assessment Model (SSAM) to signalized intersections, demonstrating its effectiveness in identifying potential conflicts proactively [2]. These works highlight the relevance of conflict-based safety analysis in urban traffic management.

Research in Nepal has shown that intersections pose significant risks to pedestrians. Budhathoki, Shrestha and Tiwari assessed vehicle-pedestrian safety at Old Sinamangal intersection using SSAM [3], while K.C. and Shahi examined pedestrian safety at crosswalks of unsignalized intersections [4]. Both studies underline the vulnerability of pedestrians in mixed traffic conditions and the need for systematic safety evaluation. International literature also supports this approach, with studies by three different studies ([5], [6], [7]) reinforcing the global relevance of conflict-based research.

Microsimulation tools like VISSIM, combined with SSAM, have been widely applied to model traffic flow and assess safety. Studies by Wu, Essam and Senna, and Ranjit and Shrestha demonstrated how simulation-based approaches can evaluate pedestrian flow and safety impacts [8] , [9]. These methods provide surrogate safety measures such as Time-to-Collision (TTC) and Post-Encroachment Time (PET), which are crucial for quantifying conflicts.

While many studies have focused on congestion or general traffic flow, fewer have concentrated on pedestrian safety at specific intersections in Nepal using advanced microsimulation tools. This gap justifies the need for a focused study at the Satdobato intersection, one of the busiest and most complex junctions in Lalitpur, which remains underexplored despite significant pedestrian-vehicle interaction.

1.2 Research Objectives

The main objective of the study is to identify and quantify vehicle-pedestrian conflicts at the Satdobato intersection using microsimulation. The specific objectives are:

- To develop and calibrate a microsimulation model of the Satdobato intersection using VISSIM software, based on observed traffic volumes, signal timings, and pedestrian volume.
- To extract and quantify conflicts from the calibrated microsimulation model using the Surrogate Safety Assessment Model (SSAM).
- To provide data-driven recommendations for enhancing pedestrian safety at the studied intersection.

2. Literature Review

A traffic conflict is an observable event where two or more road users approach each other such that a collision is imminent unless an evasive maneuver is performed. These conflicts serve as surrogate safety measures, essential because accidents are statistically rare and provide an insufficient basis for safety assessment [1].

The severity of vehicle-pedestrian interactions is quantified using temporal indicators. Time-to-Collision (TTC) is the time remaining until a collision occurs if both users maintain their course and speed. Post-Encroachment Time (PET) measures the time gap between one user leaving a conflict point and another arriving at the same point. The Pedestrian Safety Margin (PSM) assesses lane-by-lane crossing safety, while the Pedestrian-Vehicle Scaled Risk Indicator (PVSRI) integrates safety margin with vehicle speed [10].

Microscopic simulation models the movement of individual road users. VISSIM is widely used for urban traffic analysis, generating detailed trajectory files [11]. The fidelity of any simulation model depends upon calibration. The GEH statistic is the standard metric for volume calibration, with values below five indicating acceptable agreement [12]. Validation tests model performance using an independent dataset.

Once validated, trajectory files are processed by the Surrogate Safety Assessment Model (SSAM), which identifies conflicts based on TTC and PET thresholds and classifies them as rear-end, lane-change, or crossing [2]. SSAM validity has been substantiated across diverse intersection types [13].

Within Nepalese context, at Old Sinamangal Intersection, SSAM identified over three thousand conflicts during a single peak hour [3]. At New Baneshwor Intersection, TTC and PET thresholds of 1.5 seconds and 5 seconds were found appropriate for heterogeneous traffic conditions [1]. At Machhapokhari Intersection, traffic police presence, pedestrian markings, and reduced crossing width enhanced perceived safety [4]. Pedestrian red-light violations at signalized crosswalks in Kathmandu showed that thirty-five % of pedestrians violated signals upon arrival [14].

International studies have established TTC and PET thresholds for pedestrian-vehicle interactions at 2.7 seconds and 8 seconds respectively [8]. Indian research has highlighted that pedestrian fatalities account for approximately twenty % of all road accident deaths ([15], [7]).

Consequently, although surrogate safety measures have been applied in Nepalese research, no investigation has systematically quantified vehicle-pedestrian conflicts at a signalized intersection under Kathmandu's heterogeneous traffic conditions [1].

3. Methodology

3.1 Study Area

Satdobato Intersection in Lalitpur, Nepal, was selected as the study area considering heavy pedestrian movement, mixed traffic, frequent jaywalking, and being a signalised intersection. The intersection serves as a gateway for vehicles traveling to and from Kathmandu, Lalitpur, and Bhaktapur, resulting in heavy traffic flow throughout the day. The area hosts schools, colleges, commercial centers, and residential zones, generating significant pedestrian movement. Many pedestrians cross the intersection to access public transport stops, shops, and institutions. The intersection design prioritizes vehicle movement over pedestrian safety, with narrow sidewalks, absence of pedestrian islands, and poorly marked zebra crossings that discourage safe pedestrian behavior. Rapid urbanization around Satdobato has intensified land use without proportional infrastructure upgrades, making the intersection a hotspot for vehicle-pedestrian conflicts.

3.2 Source of Data

Sources of data for this study were primarily based on continuous video recordings obtained through CCTV cameras installed at the intersection from 19thNov,2025 to 21stNov, 2025.The data collection was carried out over a period of three consecutive days to ensure reliability and consistency in observed traffic patterns. From the recordings, peak traffic hours were observed, typically during the morning and evening periods when vehicle and pedestrian interactions are at their highest intensity. Since CCTV cameras were mounted at elevated and fixed positions, they provided a stable and comprehensive view of the intersection geometry, traffic streams, and pedestrian movements. Data on classified vehicle volumes and pedestrian volume with directional turning movement were noted using CCTV footage. Vehicle speeds were estimated using frame-by-frame analysis by tracking vehicle displacement over known distances. Traffic signal timings were also collected through CCTV video recordings.

3.3 Analysis Tools

A range of analytical tools were used to record, analyze, and report the study data and findings. Microsoft Excel was used for organizing, cleaning, and performing basic statistical analysis on extracted data, including traffic counts, conflict frequencies, and average speeds. PTV VISSIM, a widely used microscopic simulation software for modeling urban traffic, was employed to simulate vehicles, pedestrians, and signal controls. VISSIM generates detailed trajectory files crucial for subsequent conflict analysis and requires a combination of geometric, traffic signal, behavioral, and calibration data to accurately simulate intersections like Satdobato. The Surrogate Safety Assessment Model (SSAM) was used to transform raw simulation trajectories into safety performance indicators. SSAM processes trajectory data exported from VISSIM, derives conflict events (rear-end, lane-change, crossing), and calculates surrogate safety measures like TTC and PET.

3.4 Microscopic Simulation Model

The data from the video footage was used to develop a base model in VISSIM with the actual geometry and input data. The initial simulation results were compared with observed field values for parameters such as traffic volume and pedestrian speed. Key driver behavior parameters including desired speed distribution, minimum headway, look-ahead distance, look-back distance, and lane-changing behavior were adjusted iteratively to reduce differences between simulated and real data. Additionally, pedestrian walking behaviors were adjusted to improve the representation of pedestrian movement.

The accuracy of calibration was evaluated using statistical measures. The GEH statistics were used for traffic volume, where values less than 5 indicate acceptable agreement, values between 5 and 10 suggest caution, and values greater than 10 indicate unacceptable model performance. For pedestrian speed, the Root Mean Square Normalized Error (RMSNE) was employed to quantify the difference between simulated and observed speed distributions, with a value less than 0.15 considered acceptable. Validation ensured that the calibrated model reliably represented real-world traffic conditions by comparing simulation outputs with independent field data not used during calibration. A successfully validated model ensured confidence in its application for further analysis, such as evaluating vehicle-pedestrian conflicts and improving intersection safety.

3.5 SSAM Based Conflict Analysis

The methodology of SSAM was applied to evaluate traffic safety by analyzing vehicle-pedestrian interaction data obtained from microscopic traffic simulation. The first step was to generate vehicle and pedestrian trajectory data from VISSIM. These trajectory files contained detailed information such as position, speed, and time at small intervals. Multiple simulation runs were performed to capture variability in traffic behavior.

The second step was data import into SSAM. The trajectory files generated from the simulation, verified for its accuracy in representing study area traffic condition and imported into the SSAM software. The third step was conflict identification. SSAM processed the trajectory data to detect potential conflicts using surrogate safety measures. Time to Collision (TTC) and Post Encroachment Time (PET) were used as the primary indicators with TTC = 2.7 seconds and PET = 8 seconds taken as standard values.

The fourth step was conflict classification and filtering. Based on vehicle-pedestrian movement patterns, conflicts were categorized into types such as rear-end, lane-change, and crossing conflicts. Minor or insignificant interactions were screened out. The conflicts that satisfied the defined TTC and PET threshold values were considered for detailed analysis. The fifth step was the result analysis and interpretation. The output obtained from SSAM included the number of conflicts, their types, and their spatial distribution across the study area. The results were used for safety evaluation and comparison of improvement scenarios.

4. Calibration and Validation of Model

4.1 Calibration of Driving Behavior and Walking Behavior

The calibrated values of sensitive parameters are presented in Table 1. The minimum look ahead distance was calibrated from the default value of 0 to 10 meters, while the minimum look back distance was calibrated from 0 to 15 meters. The average standstill distance was reduced from 2 meters to 0.3 meters. The additive part of safety distance was reduced from 2 to 0.2, and the multiplicative part of safety distance was reduced from 2 to 0.1. The minimum lateral distance while driving at 50 km/h was reduced from 1 meter to 0.6 meters. These adjustments allowed the simulation model to more accurately replicate the heterogeneous and somewhat disordered traffic conditions characteristic of Kathmandu Valley intersections.

Table 1. Driving Behavior

S.N.	Sensitive Calibration Parameters	Default Value	Calibrated Values
1	Minimum look ahead distance	0	10
2	Minimum look back distance	0	15
3	Maximum look back distance	150	150
4	Average standstill distance	2	0.3
5	Additive part of safety distance	2	0.2
6	Multiplicative part of safety distance	2	0.1
7	Minimum clearance(front/rear)	0.5	0.5
8	Minimum lateral distance (standing) at 0 km/h	0.2	0.2
9	Minimum lateral distance (driving) at 50 km/h	1	0.6

The calibrated values of pedestrian behavior parameters are presented in Table 2. The parameter Tau represents the time gap maintained by pedestrians while moving, it was calibrated from the default value of 0.400 to 0.300, indicating quicker pedestrian reactions and shorter decision gaps. Asoclso represents the strength of social interaction at close distances between pedestrians, it was reduced from 2.720 to 2.000, while Bsoclso controls the range of close social interaction between pedestrians, it was decreased from 0.200 to 0.100, representing reduced interaction spacing and more compact pedestrian movement. Similarly, ASocMean defines the desired spacing maintained between pedestrians which was reduced from 0.400 to 0.200 and BSocMean controls the range of social interaction among pedestrians which is reduced from 2.800 to 1.000, showing that pedestrians tolerated closer proximity under dense flow conditions. The VD parameter represents the variation in desired walking speed among pedestrians and it was calibrated from 3.000 to 1.500, indicating lower variation in desired walking speed among pedestrians. However, parameters such as

ReactTon which controls how sensitively pedestrians respond to nearby conflicts or obstacles, Lambda which affects how strongly pedestrians respond to surrounding pedestrian forces and Noise which represents the variability in pedestrian movement behavior remained unchanged from their default values, as they already represented the observed field's behavior adequately. These calibrations enabled the simulation model to better replicate the dense, mixed, and closely interacting pedestrian movement conditions observed at the study intersection.

Table 2. Walking Behavior

S.N.	Sensitive Calibration Parameters	Default Values	Calibrated Values
1	Tau	0.400	0.300
2	ReactTon	8.000	8.000
3	Asoclso	2.720	2.000
4	Bsoclso	0.200	0.100
5	Lambda	0.176	0.176
6	ASocMean	0.400	0.200
7	BSocMean	2.800	1.000
8	VD	3.000	1.500
9	Noise	1.200	1.200

4.2 Calibration and Validation of Model for Traffic Volume and Speed

The calibration of the VISSIM model for traffic volume was performed using GEH statistics, which is the standard measure for comparing simulated and observed traffic volumes. The GEH formula is given by:

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}} \qquad \text{Equation 1}$$

where M is the simulated traffic volume and C is the observed traffic volume.

The comparison between simulated and observed traffic volumes for Day 1 morning period across all movements showed GEH values predominantly below 5 for total vehicle volumes, confirming that the model was well calibrated. Table 3 presents the vehicle composition of Lagankhel leg for Day 1 morning peak. Most movements achieved GEH values below 3, with only a few isolated cases approaching the caution threshold. The regression analysis between simulated and observed volumes yielded an R-squared value exceeding 0.995, indicating that the simulation model explains 99.5 % of the variance in the field data. The regression equation obtained was:

$$y = 1.0501x + 7.038 \qquad \text{Equation 2}$$

where, x=simulated volume; y=observed volume

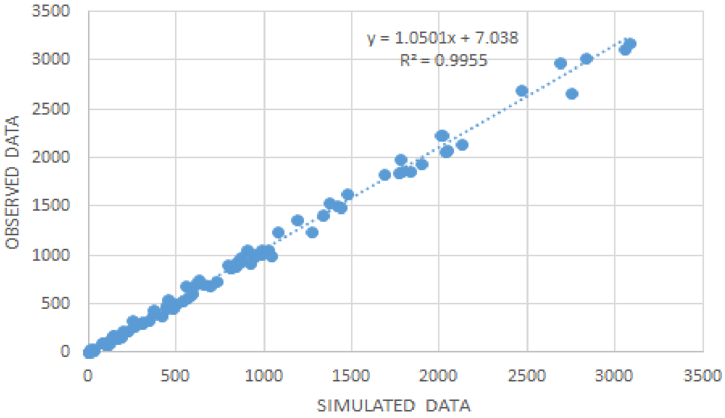


Figure 1. Calibration of VISSIM Model for Traffic Volume

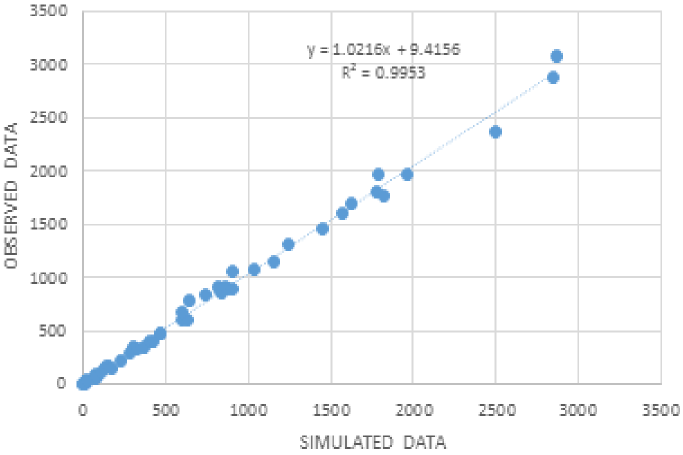


Figure 2. Validation of VISSIM Model for Traffic Volume

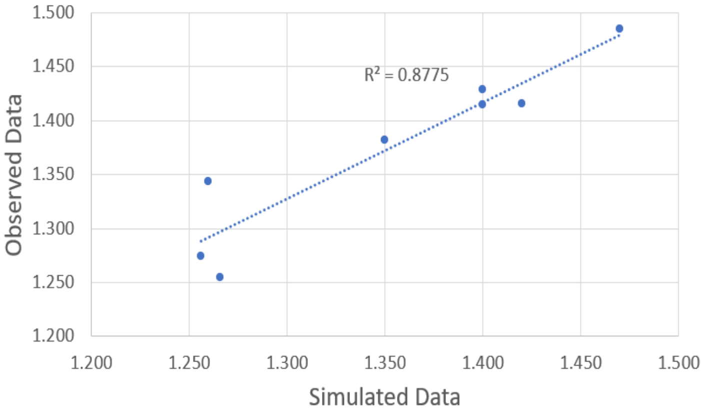


Figure 3. Observed Vs. Simulated Data for RMSNE Evaluation

Figure 1 and 2 represents calibration and validation of VISSIM model respectively. Validation of the VISSIM model was performed using independent field data not used during the calibration stage. An independent dataset from Day 2 and Day 3 was compared with simulation outputs. The GEH values for validation remained below 5 for total volumes across nearly all movements, confirming that the model reliably represents real-world traffic conditions without overfitting to the calibration dataset. The validation regression analysis produced an R-squared value of 0.995, demonstrating strong correlation between simulated and observed volumes.

Figure 3 represents RMNSE evaluation. For pedestrian speed validation, the RMSNE was again employed using independent data. The validation produced an RMSNE value of 0.031, which remains below the acceptable threshold of 0.15. Graphical comparison of observed versus simulated speeds showed a strong positive linear relationship, with points clustered closely around the trendline. The R-squared value of 0.8775 from the calibration stage indicated that approximately 87.75 % of the variation in observed speeds is explained by the simulated values.

The calibrated and validated model accurately replicated real-world traffic conditions, with GEH values below 5 and an RMSNE of 0.026.

The successfully calibrated and validated model ensured confidence in its application for further analysis, including the evaluation of vehicle-pedestrian conflicts using SSAM and the assessment of alternative improvement scenarios. The strong statistical agreement between simulated and observed data demonstrated that the model accurately replicates the complex traffic dynamics at the Satdobato intersection.

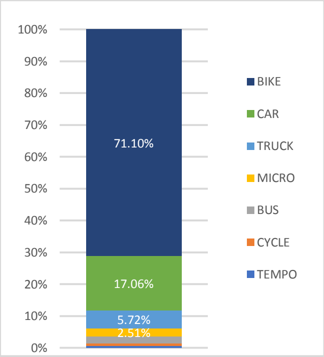
5. Data Analysis and Results

5.1 Traffic Volume and Traffic Composition

The traffic volume at Satdobato Intersection was extracted from CCTV footage recorded over three consecutive days during morning peak hours (9:00 AM to 11:00 AM) and evening peak hours (4:15 PM to 6:15 PM). The total vehicle volumes per hour for day 1 morning period (9:00 AM to 11:00 AM) of Lagankhel leg are presented in Table 3. Day 1 morning recorded the highest total volume of 11,555 PCU, while Day 3 evening recorded the lowest peak volume of 9,366 PCU.

Table 3. Vehicle Composition of Lagankhel Leg for Day 1 Morning Peak

Lane	**L**	**D**	**GS**	**GM**	**MM**	**MS**	**Total**
Bike	2079	5379	1460	3130	2434	1019	15501
Car	337	1260	390	696	793	244	3720
Micro	125	170	60	85	74	33	547
Bus	82	56	122	88	9	126	483
Tempo	75	0	0	48	0	8	131
Cycle	56	74	6	4	22	11	173
Truck	45	263	142	302	325	169	1246
Total	2799	7202	2180	4353	3657	1610	21801



L=Lagankhel, D=Dhapakhel, GS=Gwarko Service, GM=Gwarko Main, MM=Mahalaxmi Main, MS= Mahalaxmi Service

Traffic composition analysis revealed that motorcycles constituted the dominant vehicle type at Satdobato Intersection, contributing 71.10% of the total traffic volume across day 1 morning periods. Cars followed as the second most prevalent vehicle type, accounting for 17.06% of the total volume. The remaining composition consisted of trucks (5.72 %), microbuses (2.51 %), buses (2.22 %), both tempos and cycles (less than 1 %). This dominance of two-wheelers is characteristic of Kathmandu Valley's traffic stream and significantly influences pedestrian conflict dynamics due to the weaving behavior and maneuverability of motorcycles.

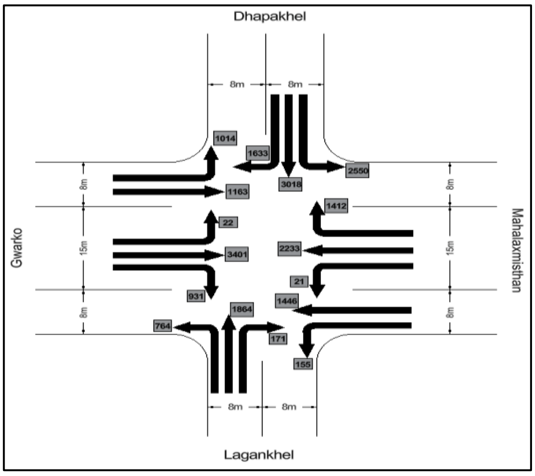


Figure 4. Directional Movement (Day 1 Morning)

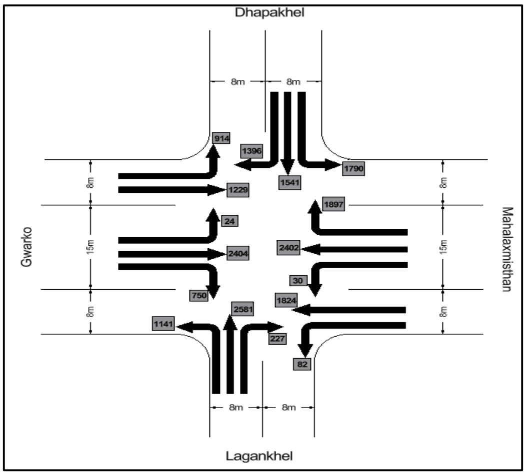


Figure 5. Directional Movement (Day 1 Evening)

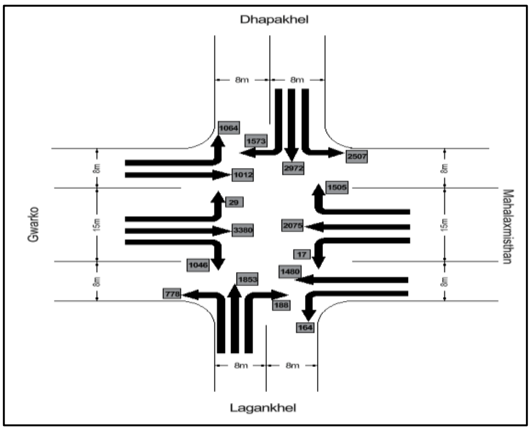


Figure 6. Directional Movement (Day 2 Morning)

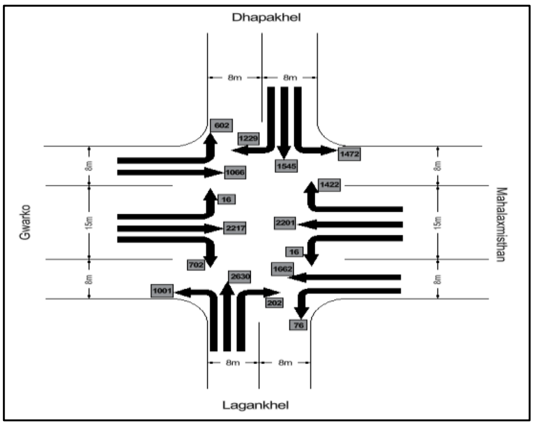


Figure 7. Directional Movement (Day 2 Evening)

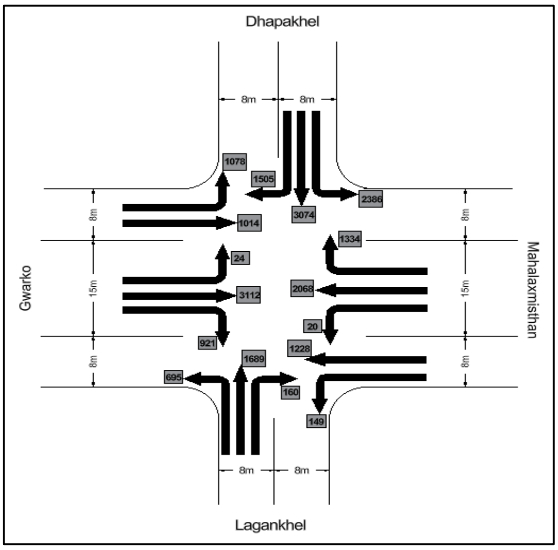


Figure 8. Directional Movement (Day 3 Morning)

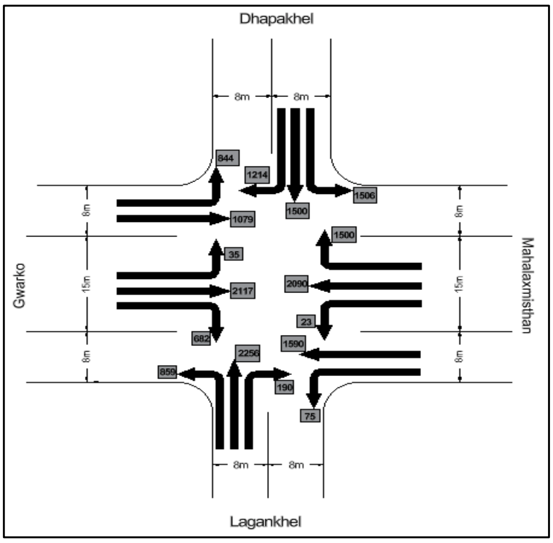


Figure 9. Directional Movement (Day 3 Evening)

Figure 4 to Figure 9 present the directional movement of vehicles for Day 1, Day 2, and Day 3 during morning and evening peak periods. The heaviest traffic flows were observed on the Dhapakhel approach and the Gwarko Main approach, while the Lagankhel approach experienced comparatively lower volumes. Turning movement analysis indicated that through movements were most frequent, followed by left turns and then right turns.

5.2 *Relative Flow*

Relative flows were calculated to establish static vehicle routing within the VISSIM model. For each origin approach, the proportion of vehicles destined for each exit approach was recorded from field observations. Figure 10 presents a sample of relative flows for the Gwarko Main Lane during morning shift of Day 1.

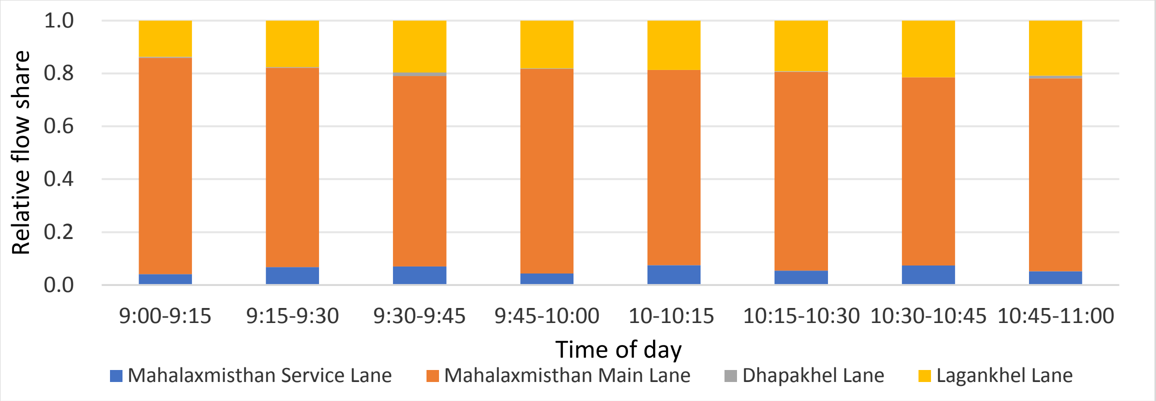


Figure 10. Relative Flow of Bikes from Gwarko Main Lane to Respective Lanes

The relative flows varied by vehicle type, reflecting different turning behavior patterns. Motorcycles and cars showed more distributed turning movements, while heavy vehicles like trucks and buses predominantly proceeded straight through the intersection. These relative flow distributions were applied as static routing decisions within the VISSIM model to accurately replicate observed traffic patterns.

5.3 Conflict Generation

The calibrated and validated VISSIM model was executed to generate vehicle and pedestrian trajectory files. These trajectory files were then imported into SSAM for conflict analysis. Time to Collision (TTC) and Post Encroachment Time (PET) thresholds were set at 2.7 seconds and 8 seconds respectively, following the established methodology for heterogeneous traffic conditions.

Table 4 presents the vehicle-pedestrian conflicts generated by SSAM for morning and evening periods across three days, categorized by vehicle type. In the morning session, total conflicts were significantly higher compared to the evening. Day 1 showed the highest number of conflicts (2,680), followed by Day 2 (1,599) and Day 3 (1,584). Among vehicle types, cars and bikes contributed the most to conflicts, with cars consistently having the highest values, indicating their dominant presence and interaction with pedestrians. Trucks and microbuses also showed notable conflict numbers, while tempos, cycles, and buses contributed relatively less.

Table 4. Vehicle Pedestrian Conflicts

Vehicle Type	Evening			Morning		
	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
Bike	207	384	233	935	553	428
Car	101	730	520	1,126	631	766
Truck	7	136	99	218	133	92
Micro	34	150	122	218	181	149
Tempo	15	21	22	38	23	34
Cycle	2	12	7	26	5	12
Bus	28	84	48	119	73	103
Total	394	1,517	1,051	2,680	1,599	1,584

In the evening session, overall conflicts were much lower. Total conflicts were 394 on Day 1, increasing sharply to 1,517 on Day 2, and decreasing to 1,051 on Day 3. The higher number of vehicle-pedestrian conflicts during morning peak hours is mainly due to increased traffic and pedestrian volumes, concentrated commuting activities, and more frequent road crossings. These factors create greater interaction between vehicles and pedestrians, resulting in more conflicts during morning than during the evening peak period. Similar to the morning trend, cars and bikes remained the major contributors, especially on Day 2 where car-related conflicts peaked significantly.

Conflict classification by type revealed that crossing conflicts were most frequent, particularly during morning peak hours. Rear-end conflicts involving pedestrians were frequently precipitated by jaywalking or pedestrian hesitation during crossing maneuvers. Lane-change conflicts were particularly prevalent due to motorcycles weaving between lanes and larger vehicles repositioning to access turn bays. The spatial distribution of conflicts showed that crossing conflicts were concentrated on the Gwarko and Mahalaxmi approaches, where pedestrian volumes were highest.

5.4 Alternatives Scenarios

Two alternative scenarios were developed and simulated to evaluate potential safety improvements at Satdobato Intersection. Alternative 1 proposed redirecting all pedestrians from the Mahalaxmi lane to use the existing overhead crossing. Alternative 2 proposed constructing a new overhead crossing at the Gwarko lane and redirecting pedestrians from both Mahalaxmi and Gwarko lanes through their respective overhead facilities.

Table 5 presents the vehicle-pedestrian conflict counts under the existing condition and the two alternative scenarios. Under the existing condition, total conflicts were highest at 2,680. In Alternative 1, total conflicts dropped to 2,308, representing a reduction of 13.88 %. All vehicle categories showed a decrease, with bikes reducing from 935 to 803 and cars reducing from 1,126 to 1,017.

Table 5. Vehicle Pedestrian Conflicts for Proposed Alternatives

Scenario	Bike	Car	Truck	Micro	Tempo	Cycle	Bus	Total
Alternative-1	803	1017	179	175	36	20	78	2308
Alternative-2	723	555	135	122	11	13	56	1615

Alternative-1= All pedestrian from Mahalaxmi lane is redirected to use the existing overhead crossing**.**

Alternative-2= A new overhead crossing was proposed at the Gwarko lane and pedestrians from both Mahalaxmi and Gwarko lanes are moved through their respective overhead facilities.

In Alternative 2, total conflicts dropped to 1,615, indicating the most effective scenario with a 39.74 % reduction from the existing condition. All categories showed notable reductions, especially cars (from 1,126 to 555) and bikes (from 935 to 723). Minor categories like tempo and cycle became very low. The results demonstrate that both alternatives improve safety, with Alternative 2 providing the greatest reduction in conflicts.

The variation in conflict reduction percentages among different vehicle types is primarily influenced by their operational characteristics and interaction patterns with pedestrians. Cars demonstrated the highest reduction because they are particularly sensitive to pedestrian interference, requiring predictable traffic conditions. Motorcycles showed moderate reduction due to their high maneuverability and ability to navigate through gaps in traffic. Trucks exhibited moderate to high reduction due to their operational limitations and longer stopping distances. Buses experienced moderate reduction influenced by their role as mass transit vehicles with designated stops. Cycles showed relatively smaller reduction due to their slower speeds and adaptability, while tempos showed the least reduction due to their irregular operating behavior and frequent roadside stops.

6. Discussion

The study found that Satdobato Intersection experiences a high number of vehicle-pedestrian conflicts, especially during morning peak hours, mainly due to heavy mixed traffic, high pedestrian activity, and inadequate crossing facilities.

The variation in conflict reduction among vehicle categories further demonstrates that operational characteristics influence safety outcomes. Cars and trucks exhibited larger reductions because they benefit more from predictable traffic conditions and reduced pedestrian interference. In contrast, motorcycles showed comparatively smaller reductions due to their maneuverability and ability to continue weaving through traffic streams. This observation emphasizes the need for complementary measures such as enforcement, traffic calming, and public awareness campaigns alongside infrastructure improvements.

Overall, the study confirms that VISSIM and SSAM are effective tools for assessing pedestrian safety and that improved crossing infrastructure, combined with proper enforcement, can substantially reduce vehicle-pedestrian conflicts at Satdobato Intersection.

7. Conclusion

This study successfully analyzed vehicle-pedestrian conflicts at Satdobato Intersection using VISSIM microsimulation and SSAM. Conflict analysis revealed high frequencies of vehicle-pedestrian conflicts, particularly during morning peak periods. Cars and motorcycles were the dominant contributors, accounting for 75-80 % of total conflicts. Day 1 morning recorded the highest conflicts at 2,680. Figure 11 shows conflict comparison across alternatives.

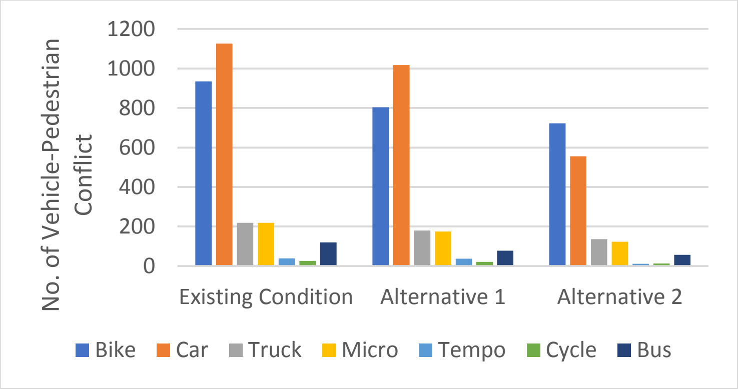


Figure 11. Conflict Comparison across Alternatives

Two alternative scenarios were evaluated. Alternative 1 (redirecting Mahalaxmi pedestrians to existing overhead crossing) reduced conflicts by 13.88 %. Alternative 2 (new overhead crossing at Gwarko lane with redirection from both lanes) proved significantly more effective, achieving a 39.74 % reduction in conflicts. The variation in conflict reduction among vehicle types indicates that cars and trucks benefit most from pedestrian segregation, while motorcycles and tempos show smaller reductions due to their flexible movement patterns. The study concludes that strategic overhead crossings, combined with traffic regulation and public awareness, can substantially improve pedestrian safety at Satdobato Intersection.

8. Recommendations

Based on the study findings, the following key recommendations are proposed:

- Construction of a new overhead crossing at the Gwarko lane and redirect pedestrians from both Mahalaxmi and Gwarko lanes to use overhead facilities is recommended based on this study as the model shows a 39.74 % reduction in pedestrian-vehicle conflicts.
- Strengthen Enforcement: There is a pedestrian bridge on the Mahalaxmi leg which is not properly utilized. With the provision of infrastructure, enforcement is equally essential.
- Conduct Regular Safety Audits: Perform periodic safety assessments using surrogate measures or others to monitor effectiveness and identify emerging conflict hotspots.
- The vehicle behavior at the intersection is chaotic as the mixed traffic is more densely packed encroaching adjoining vehicles' safety clearance zone. Density improves efficiency but at the cost of compromised safety. The traffic needs to be streamlined for predictable and safe traversing of the intersection.
- Further Research: Investigate economic analysis of interventions, pedestrian level of service, vulnerable group behavior, and service lane to main lane interactions.
- Enhance Crossing Infrastructure: Remark zebra crossings, install pedestrian refuge islands on wider approaches, and maintain adequate sidewalks.

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