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Analysis of the Effectiveness of the Performance of Flyover using VISSIM: A Case Study of Satdobato Intersection

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Abstract

Satdobato, a major junction in Lalitpur, is a congested area with high-density traffic. Field surveys revealed that traffic volumes exceed the intersection's capacity, leading to congestion. To reduce traffic delay, a new scenario with a flyover on the existing road was analyzed. PTV VISSIM, a microscopic simulation tool, was used to simulate intersection capacity and traffic performance. The flyover allowed main traffic to move uninterrupted, resulting in a 51% decrease in overall delay, a 55% decrease in average queue length, and notable improvement in average travel time. Also, the level of service improved from E to D, indicating enhanced traffic efficiency.

***Keywords*:** Flyover, Intersection, Level of Service, VISSIM

1. Background

An intersection is a vital component of the transportation network where different routes meet. This makes it easier for vehicles and individuals to merge, turn, or cross. In order to keep people safe while maintaining traffic moving smoothly, intersections need to have effective traffic control tools such as signals, signs, and road markings. Congestion at intersections is a common issue, especially in developing countries where resources are scarce and right-of-way is inadequate. Grade separation, peak hour traffic management, roundabouts, intelligent transportation systems, signal coordination, dedicated turning lanes, and public transport priority measures aresome of the methods used to improve traffic flow more effective. One of the most effective ways to reduce traffic congestion is to separate grades, which means making different levels (flyovers and underpasses) for traffic to flow without getting in the way of other traffic. Flyovers and underpasses, for example, are important parts of infrastructure that help separate traffic streams to ensure heavy traffic can flow without interruption. We think that adding more lanes and solving vehicle conflicts will make these solutions work, which will cut down on travel time by a lot. In order to construct this kind of infrastructure, more lanes need to be added, traffic lights need to be changed, lighting and signage need to be improved, and construction schedules need to be changed. Using modeling tools like VISSIM to simulate different traffic situations helps people make better decisions about how to get around and stay safe, and it also makes public spaces more useful.

The Kathmandu Valley experiences significant amounts of difficulty managing traffic flow at intersections, similarly to other underdeveloped areas. Controlling traffic at intersections in the Kathmandu Valley is a significant challenge for both traffic police and urban transport planners. The situation is made worse by the fact that the number of vehicles is growing quickly, at a rate of 12% per year, according to the Department of Transport Management (2018). The increase in vehicles on roadways has made traffic management challenging and less effective. As a result, this trend has resulted in more severe road performance and decreased overall efficiency. As a growing number of vehicles are on roadways, traffic management systems that are more environmentally friendly and automated need to be created. Infrastructure improvements such as grade separations could greatly reduce congestion and shorten travel times. However, in order to make these improvements happen, we need to plan carefully, build new infrastructure, and change our approach to design and use cities. Using advanced modeling tools like VISSIM helps make traffic management plans that are better suited to Kathmandu's needs. This method is expected to make the transportation network more efficient and safer overall.

2. Problem Statement

Traffic congestion is a significant problem in urban and semi-urban areas, particularly at intersections such as the Satdobato intersection in Nepal. This intersection serves as a critical link between neighborhoods and is vital for trade and transportation. High traffic volumes at this location result in long queues and delays, leading to substantial time loss for the public.

his study aims to evaluate the impact of a flyover on traffic performance at the Satdobato intersection. It includes the calibration and validation of a micro-simulation model to assess traffic flow, determine the level of service, and compare key performance indicators such as delay, queue length, and average speed, both with and without the presence of a flyover.

3. Literature Review

PTV VISSIM (2023) is a time-step and behavior-based traffic simulation model developed by the University of Karlsruhe in the 1970s. It consists of a traffic simulator and signal state generator, capable of modeling urban traffic and public transit operations. VISSIM can produce commonly used traffic engineering measurements and can model different vehicle types for freeways and arterials under complex traffic control situations. It can visualize complex traffic flow graphically and aid in transportation planning.

Pradhananga et al. (2021) examined the effectiveness of Reversible Lane Systems (RLS) in the Kathmandu Valley, focusing on the Jadibuti-Koteswor section to improve traffic flow during peak morning and evening hours. Using travel time and queue length as indicators, a micro-simulation model was developed in VISSIM. The study revealed that implementing RLS in this section could reduce queue lengths by more than 50% and improve travel times by an average of 11% during peak hours.

Luitel et al. (2024) evaluated two scenarios for an intersection: left-turn control with optimal cycle length and cycle length optimization. The results, assessed during peak hours, were compared based on delay time, level of service (LOS), and queue length. The findings showed that incorporating left-turn maneuvers into signal-controlled intersections, rather than allowing free turns, was more effective in significantly reducing average delay and queue length, as well as improving LOS. Performance variations were compared using LOS, average delay, and back of queue metrics.

Shrestha and Marsani (2017) evaluated the New Baneshwor Intersection using VISSIM. They found that the Level of Service (LOS) was F during both morning and evening peak hours. They proposed five different alternatives to reduce congestion. Among the five alternatives, the three-phase signal planning with a flyover, providing a U-turn, was found to be the most effective. This approach reduced delay and travel time by 81.92% and 80.1% in the morning and evening peak hours, respectively, maintaining a Level of Service C. Additionally, it was observed that traffic congestion in Maitighar, Tinkune, Old Baneshwor, and Sankhamul lanes decreased by at least 60% during peak hours

Performance measures such as travel time and delay are commonly used metrics to assess traffic facility performance. The Highway Capacity Manual (HCM, 2000) uses average travel speed for arterials and two-lane rural highways, while control delay evaluates signalized intersections. Qualitative measures like public feedback and observer observations can provide more precise evaluations.

In a study by Abojaradeh et al., traffic at a signalized intersection was analyzed using the Highway Capacity Manual (HCM, 2000) and Highway Capacity System (HCS) computer models. The analysis revealed a delay of 473 seconds per vehicle, resulting in a Level of Service (LoS) rating of F. The study proposed four different alternatives, and the fourth option, which involved constructing two overpasses, was found to be the most effective. This alternative reduced the Level of Service to LoS-C, with a delay of 27 seconds per vehicle.

4. Limitations

i. Volume count was conducted only between 9:15 AM and 10:15 AM, assuming this to represent the peak hour.

ii. Data collection was limited to three weekdays; weekends were not included in the analysis.

iii. Environmental factors, such as weather and visibility conditions, were not taken into account.

iv. Pedestrian activity was not considered in the study.

5. Study Area

The research focuses on the Satdobato intersection located in Lalitpur district as shown in Figure 1. Satdobato is a busy intersection and an important link for traffic in and out of Lalitpur, especially connecting to major roads like the Ring Road. This makes it a good spot to study urban growth, road expansions, and how infrastructure affects the area.

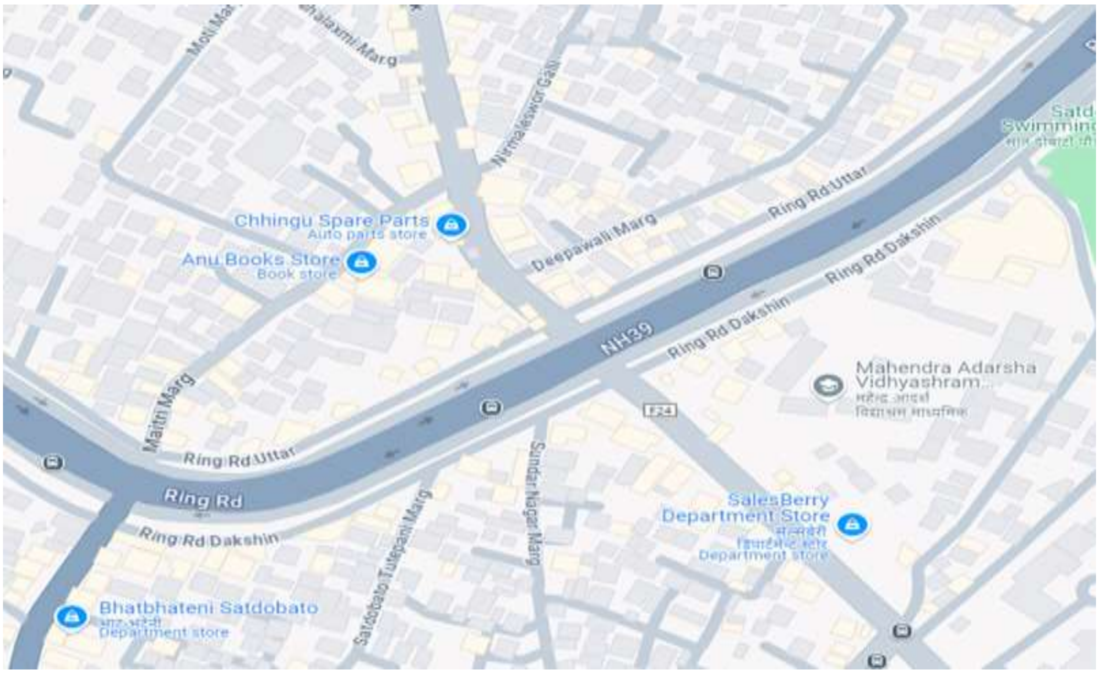


Figure 1. General layout of Satdobato intersection.

6. Data Collection

Field data collection included intersection geometry, turning movement counts, AM peak hour observation, classified count of vehicles, time and phasing information for traffic police signals, and video graphics data. The video recording was adopted for the data gathering, with four video cameras deployed for the four intersection approaches and subsequent traffic count later manually. The classification adopted for the traffic count purpose was shown in Table 1 with size of vehicle shown.

Table 1. Size of Vehicles

Vehicle	Length (meters)	Width (meters)
Car	4.5-4.8	1.7-1.8
Bike	21-23	0.8-0.9
Truck	Varies	2.5-2.6
Van	5-6	1.8-2.0
Bus	Varies	2.5-2.6
Minibus	5-7	1.8-2.0

6.1 Traffic volume count

The Table 2 below present the summary of traffic volume count in terms of PCU at the Satdobato intersection. According to the traffic survey, during the morning peak hour, there is significant traffic demand flow from Ekantakuna and Gwarko compared to all the other directions (as indicated in table). This is due to the arrival at the offices and business centers in the Nayabasti, Thasikhel, Kalanki, etc. areas near Kathmandu Valley.

Table 2. Traffic flow in PCU

Direction	Total Traffic Flow (Veh/hr)	Total Traffic Flow (PCU/hr)
EKANTAKUNA	4286	3584
GWARKO	5085	3927.5
GODAWARI	6282	4090.5
LAGANKHEL	1582	1216
TOTAL	**17235**	**12818**

6.2 Vehicle composition

Traffic surveys showed that motorcycle was found to be one of the major modes of transportation. The overall composition of the vehicle is shown in Table 3. Typically, at Satdobato intersection, Motorbike/Scooter was found to be 73%, Car/Jeep/Pick up/ Van 24 %, Minibus/Micro Bus 2.5 %, and Heavy Truck/Light Truck 2.8 % total in composition from all direction in day 1, Monday.

Table 3. Vehicle composition

	Bike	Bus	Car	Truck	Total
Volume	6738	232	2228	265	9463
%	73	2.511	24.11	2.868	100

6.3 Vehicle movement and relative flow

The flux of vehicle flow movement was observed to be increased rapidly from Gwarko to Ekantakuna during morning peak time. Relative flow of traffic of 1 day in each direction was calculated and shown in Table 4, 5m 6 and 7 respectively. The alphabet a, b, c and d represent lane direction of road namely, Ekantakuna, Godawari, Gwarko, and Lagankhel respectively as shown in Figure 2.

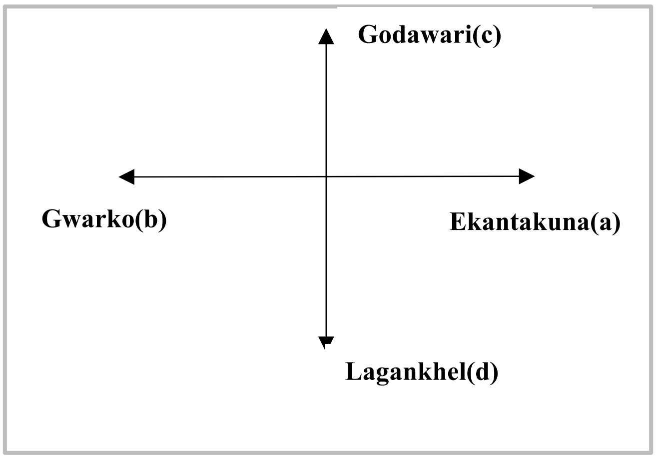


Figure 2. Schematic Figure of Intersection of Satdobato

Table 4. Relative Flow for Ekantakuna Lane (a)

End Time	Bike				Bus				Car				Van								Truck							
	a to				a to				a to				Light (a to)				heavy (a to)				Light (a to)				Heavy (a to)			
	b (ser)	b	c	d	b ser	b	c	d	b ser	b	c	d	b ser	b	c	d	b ser	b	c	d	b ser	b	c	d	b ser	b	c	d
9:15-9:30	0.12	0.63	0.24	0.01	0.85	0.15	0.00	0.00	0.20	0.50	0.28	0.01	0.18	0.75	0.03	0.05	0.18	0.75	0.03	0.05	0.70	0.03	0.03	0.05	0.70	0.20	0.10	0.00
9:30-9:45	0.19	0.34	0.78	0.05	0.88	0.06	0.06	0.00	0.25	0.45	0.28	0.03	0.25	0.67	0.08	0.00	0.25	0.67	0.08	0.00	0.50	0.08	0.08	0.00	0.50	0.50	0.00	0.00
9:45-10:00	0.15	0.59	0.76	0.03	0.37	0.11	0.11	0.00	0.24	0.45	0.31	0.00	0.29	0.67	0.05	0.00	0.29	0.67	0.05	0.00	0.60	0.05	0.05	0.00	0.60	0.40	0.00	0.00
10:00-10:15	0.10	0.58	0.81	0.03	0.77	0.00	0.00	0.00	0.12	0.46	0.42	0.00	0.08	0.50	0.42	0.00	0.08	0.50	0.42	0.00	0.00	0.42	0.42	0.00	0.00	0.75	0.25	0.00

Table 5. Relative Flow for Gwarko Lane (b)

End Time	Bike				Bus				Car				Van								Truck							
	b to				b to				b to				Light (b to)				Heavy (b to)				Light (b to)				Heavy (b to)			
	a (ser)	a	c	d	a ser	a	c	d	a ser	a	c	d	a ser	a	c	d	a ser	a	c	d	a ser	a	c	d	a ser	a	c	d
9:15-9:30	0.13	0.52	0.2	0.14	0.55	0.1	0.0.	0.31	0.2	0.41	0.23	0.17	0.1	0.65	0.1	0.16	0.0	1.0	0.0	0.0	0.29	0.18	0.41	0.12	0.0	0.5	0.5	0.0
9:30-9:45	0.13	0.54	0.21	0.11	0.67	0.1	0.05	0.19	0.17	0.35	0.23	0.25	0.11	0.53	0.19	0.17	0.0	0.44	0.33	0.22	0.67	0.17	0.17	0.1	0.0	1	0.0	0.0
9:45-10:00	0.119	0.41	0.28	0.12	0.7	0.04	0.04	0.22	0.12	0.38	0.25	0.26	0.22	0.44	0.27	0.07	0.11	0.56	0.11	0.22	0.25	0.25	0.38	0.13	0.0	1	0.0	0.0
10:00-10:15	0.04	0.52	0.26	0.17	0.58	0.04	0.13	0.25	0.17	0.33	0.28	0.22	0.18	0.53	0.13	0.16	0.2	0.2	0.2	0.4	0.64	0.27	0.09	0.0	0.75	0.13	0.13	0.1

Table 6. Relative Flow for Godawari Lane (c)

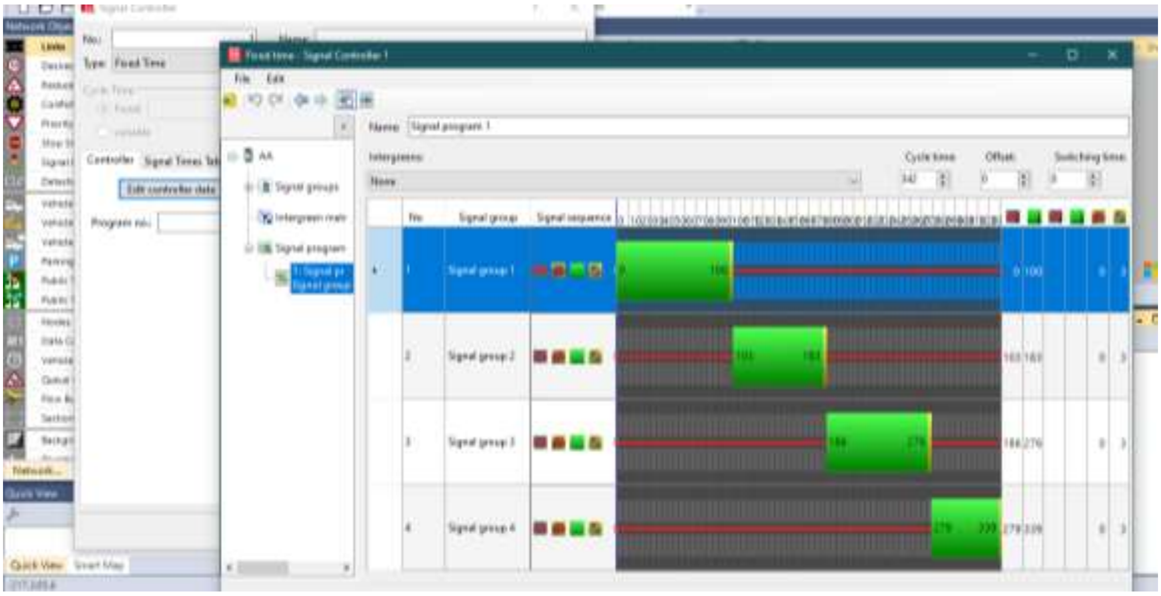
End Time	Bike			Bus			Car			Van						Truck					
	c to			c to			c to			Light (c to)			heavy (c to)			Light (c to)			Heavy (c to)		
	a	b	d	a to	b	d	a	a	b	d	a to	b	d	a	a	b	d	a to	b	d	a
9:15-9:30	0.27	0.25	0.48	0.25	0.00	0.75	0.34	0.31	0.35	0.36	0.24	0.39	0.00	0.00	0.00	0.60	0.40	0.00	0.50	0.50	0.00
9:30-9:45	0.33	0.21	0.45	0.00	0.33	0.67	0.31	0.28	0.41	0.29	0.29	0.43	0.00	0.00	0.00	0.50	0.38	0.13	1.00	0.00	0.00
9:45-10:00	0.31	0.23	0.46	0.43	0.00	0.57	0.44	0.26	0.30	0.24	0.41	0.34	0.50	0.50	0.00	0.17	0.83	0.00	0.50	0.50	0.00
10:00-10:15	0.39	0.20	0.41	0.29	0.14	0.57	0.40	0.29	0.31	0.42	0.29	0.29	0.50	0.50	0.00	0.43	0.14	0.43	0.00	1.00	0.00

Table 7. Relative Flow for Lagankhel Lane (d)

End Time	Bike			Bus			Car			Van						Truck					
	d to			d to			d to			Light (d to)			heavy (d to)			Light (d to)			Heavy (d to)		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
9:15-9:30	0.08	0.16	0.76	0.22	0.33	0.44	0.00	0.46	0.54	0.10	0.52	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9:30-9:45	0.05	0.15	0.80	0.20	0.50	0.30	0.00	0.24	0.76	0.00	0.40	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9:45-10:00	0.08	0.11	0.81	0.18	0.45	0.36	0.00	0.26	0.74	0.04	0.65	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
10:00-10:15	0.07	0.20	0.73	0.29	0.43	0.29	0.11	0.11	0.78	0.00	0.29	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.33

6.4. Traffic signal

At the Satdobato intersection in Lalitpur, Nepal, traffic signal management is actively controlled by traffic police officers who adjust signal timings based on real-time traffic conditions. This dynamic approach ensures that green and red light durations are continuously optimized to accommodate fluctuating traffic volumes, enhancing both efficiency and safety. To inform traffic simulation models, a comprehensive video survey was conducted to determine the total green and red times for various lanes. The analysis revealed a total cycle time of 330 seconds, divided into four phases: 100 seconds for the first phase, 80 seconds for the second, and 90 and 60 seconds for the third and fourth phases, respectively. Each phase included a 3-second amber light. These findings were subsequently input into the VISSIM software for further analysis.



(Source: VISSIM Software,2024)

Figure 3. Signal Controller in VISSIM

6.5. Speed distribution

Analyzing speed distribution with cumulative factors gives a complete picture of velocity changes over time. This helps optimize systems and improve efficiency in different areas, like data analysis, with practical real-world benefits. We employed stopwatches for quantifying the travel durations of vehicles traversing from one designated point to another. This methodological choice facilitated the precise measurement of elapsed time intervals, enabling a thorough analysis of vehicular travel patterns and speeds. The observed speed distribution which was employed in VISSIM model development and analysis is shown in Figure 4.

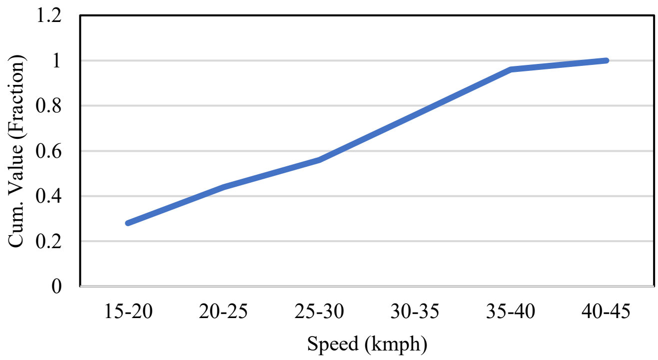


Figure 4. Speed Distribution (S Curve)

7. Research Design and VISSIM Model Development

The research methodology involved a structured approach to simulate and analyze traffic conditions at the Satdobato intersection. Primary data were collected manually, encompassing traffic volume, speed, and signal timings. This data informed the development of a microscopic traffic simulation model using PTV VISSIM, which was calibrated and validated to reflect real-world conditions. Calibration entailed adjusting parameters such as car-following behavior and lane-changing dynamics to minimize discrepancies between simulated and observed traffic performance, with GEH statistics and RMSE metrics used to assess accuracy .

The VISSIM model was constructed by defining the road network, lanes, intersections, and traffic signals, utilizing aerial imagery from tools like Google Earth. Traffic signal phases and timings were set to match field conditions. The simulation incorporated various vehicle types, including cars, trucks, and buses, each with specific characteristics such as maximum speed and driver behavior. Following calibration, the model was validated using independent traffic data not involved in the calibration process. Validation metrics, including GEH statistics for traffic volume and RMSE for travel time, confirmed the model's accuracy. Subsequently, the impact of introducing a flyover was analyzed, focusing on key performance indicators such as travel time, delays, queue lengths, and Level of Service (LOS). The complete steps of VISSIM model development and analysis is presented in Figure 5.

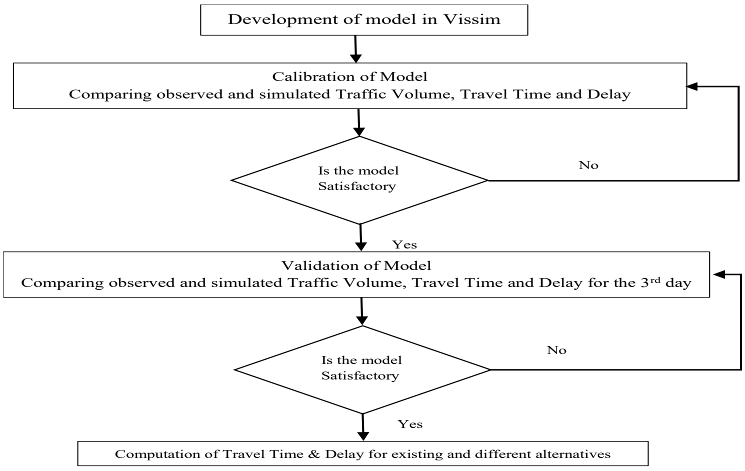


Figure 5. VISSIM Simulation Modeling and Analysis

8. Discussion on an Alternative

A flyover, or elevated roadway, is a bridge-like structure that helps traffic bypass obstacles or busy intersections, reducing congestion and improving safety by minimizing accidents at ground level. In urban areas like Kathmandu, flyovers are crucial for easing traffic flow and enhancing efficiency. For example, a flyover at the Satdobato Intersection could alleviate severe congestion and support infrastructure improvements. A study by Hadiya and Jain (2016) highlighted the benefits of flyovers, including significant savings in travel time and fuel, and a reduction in accident costs, underscoring their value in urban planning.

Figure 6. Intersection of Satdobato

We selected the Gwarko to Satdobato Road for our study due to its high traffic volume and frequent congestion, which pose significant challenges for traffic management. As a major route for commuters and commercial vehicles, it often becomes overburdened, leading to long delays, increased fuel consumption, and pollution. In contrast, the Godawari to Lagankhel route was not chosen because it is narrower with lower traffic volume and less severe congestion. Thus, we focused on the Gwarko to Satdobato Road, where addressing congestion is more critical for improving traffic flow and efficiency.

9. Calibration Result

The calibration of the model was done in VISSIM for driving behavior, traffic volume, travel time, and delay which are given in the following subheadings. The VISSIM protocol provides suitable default driving parameters for both heterogeneous and homogeneous traffic, allowing for the calibration of the model. After inputting the driver behavior parameters based on prior research, multiple adjustments are made through trial and error of individual values to set the driving behavior parameters. Ultimately, the optimal value is determined and recorded in the table 8 for car following parameters, table 9 for lane changing parameters and table 10 for lateral parameters outlined below.

Table 8. Calibrated Value of Car Following Parameter

S.N.	**Driving Behavior Parameters**	**Units**	**Default Value**	**Calibrated Value**
I	Look Ahead Distance Minimum	m	10	**27.80**
II	Look Ahead Distance Maximum	m	150	**124**
III	Look Back Distance Minimum	m	10	**14.36**
IV	Look Back Distance Maximum	m	100	**150**
V	Smooth Close-up Behavior		Unchecked	Unchecked
VI	Stand Still Distance Static Obstacles	m	0.5	**0.63**
VII	Average Standstill Distance	m	2	**0.32**
VIII	Additive Part of Safety Distance	m	2	**0.19**
IX	Multiplicative Part of Safety Distance	m	3	**0.71**

Table 9 Calibration Parameter of Lane Change Behavior

S.N.	Lane Change Behavior parameters	**Default Value**	**Calibrated Value**
I	**General Behavior**	**Free Lane Selection**	**Free Lane Selection**
II	Waiting time before diffusion	60 sec	**60**
III	Minimum Headway (Front/Rear)	0.5 m	**0.14**
IV	Overtake Reduced Speed Areas	unchecked	**Checked**
V	Advanced Merging	unchecked	**Checked**
VI	Consider subsequent static routing decisions	unchecked	**Checked**

Table 10. Lateral Parameter

S.N.	**Lateral Parameters**	**Default Value**	**Calibrated Value**
I	Desired Position at Free Flow	Any	**Any**
II	Keep Lateral Distance to Vehicles on Next Lanes	unchecked	**Checked**
III	Diamond Shaped Queuing	unchecked	**Checked**
IV	Consider Next Turning Direction	unchecked	**Checked**
	Overtake on the same lane		
V	a.) on left	unchecked	**Checked**
	b.) on right	unchecked	**Checked**

9.1 Calibration of volume

For the calibration of the traffic volume, the simulated traffic volume was compared with the observed traffic volume for different directions. To check the accuracy of output, GEH statistic (Equation 1) was used for observed and simulated traffic volume. The test result shows that most of the GEH values are below 5. Very few results were obtained above 5.

$$GEH = \sqrt{\frac{2(m-c)^2}{m+c}} \quad \text{(Equation 1)}$$

Where,

m= output of traffic volume from simulation model

c=input traffic volume (vph)

Table 11. Calibration of Traffic Volume Per 15 min.

S.N.	Traffic Volume	Input				Output				GEH			
		Bike	Bus	Car	Truck	Bike	Bus	Car	Truck	Bike	Bus	Car	Truck
1	Ekantakuna(SL)-Gwarko(SL)	41	17	37	15	38	13	29	10	0.48	0.13	0.12	0.20
2	Ekantakuna(SL)-Lagankhel	3	0	3	0	0	0	1	0	2.45	-	0.50	-
3	Ekantakuna(ML)-Gwarko(ML)	213	3	101	12	197	1	96	8	1.12	0.50	0.03	0.20
4	Ekantakuna(ML)-Godawari	81	0	34	9	77	0	30	3	0.45	0.00	0.06	0.50
5	Lagankhel-Gwarko(SL)	18	3	23	0	10	0	18	0	2.14	1.00	0.12	-
6	Lagankhel-Godawari	84	4	22	0	79	1	17	0	0.55	0.60	0.13	-
7	Lagankhel-Ekantakuna	9	2	2	0	4	0	0	0	1.96	1.00	1.00	-
8	Gwarko(SL)-Ekantakuna(SL)	58	16	29	5	50	11	22	1	1.09	0.19	0.14	0.67
9	Gwarko(SL)-Godawari	88	1	32	9	84	1	27	4	0.43	0.00	0.08	0.38
10	Gwarko(ML)-Ekantakuna(ML)	225	3	92	5	217	0	77	1	0.54	1.00	0.09	0.67
11	Gwarko(ML)-Lagankhel	60	9	29	2	55	3	22	0	0.66	0.50	0.14	1.00
12	Godawari-Gwarko	149	0	47	5	137	0	40	2	1.00	0.00	0.08	0.43
13	Godawari-Lagankhel	294	3	57	0	287	0	49	0	0.41	1.00	0.08	0.00
14	Godawari-Ekantakuna	165	1	54	7	156	0	50	3	0.71	1.00	0.04	0.40

Note: SL-Service Lane, ML- Main Lane

9.2 Calibration of travel time

To calibrate the travel time, we compared the simulated travel time with the observed travel time. We utilized Normal Root Mean Squared Error (NRMSE) to assess the accuracy of the output, which quantifies the percentage deviation between the simulated and observed data. Nearly all NRMSE values were below 0.3. RMSE and NRMSE can be calculated as equation (2) and (3):

$$RMSE = \sqrt{\frac{\sum(x_{obs}-x_{model})^2}{n}} \quad \text{(Equation 2)}$$

The normalized root mean square error is:

$$NRMSE = \frac{RMSE}{x_{obs}} \quad \text{(Equation 3)}$$

Table 12. Calibration of travel time

S.N	Vehicle Movement	Travel time		RMSE	NRMSE
		Observed	Stimulated		
1	Lagankhel to Godawari	16.6	18.066	1.466	0.0088
2	Gwarko to Ekantakuna	11.122	16.58	5.458	0.490
3	Godawari To Lagankhel	14.505	25.41	10.905	0.751
4	Ekantakuna to Gwarko	11.226	15.47	4.244	0.37

10. Validation of Model

Simulation was done to get output in calibrated model and comparison was done with calibrated driving behaviors parameters for volume and Travel time. Outputs from VISSIM which were compared with the same observed parameters in the same day. Validation was done with the data obtained and simulated data.

10.1 Validation of traffic volume

For the validation of the traffic volume, the simulated traffic volume was compared with the observed traffic volume for each vehicle composition at each 15-minute interval for the field data. To check the accuracy of output, GEH statistic was again used for observed and simulated traffic volume. The test result shows that most of the GEH values are given in Table 13.

Table 13. Validation of 15 min Traffic Volume.

S.N.	Traffic Volume	Input				Output				GEH			
		Bike	Bus	Car	Truck	Bike	Bus	Car	Truck	Bike	Bus	Car	Truck
1	Ekantakuna(SL)-Gwarko(SL)	35	22	24	14	27	17	19	10	1.44	1.13	1.08	1.15
2	Ekantakuna(SL)-Lagankhel	9	0	6	0	4	1	2	0	1.96	1.41	2.00	0.00
3	Ekantakuna(ML)-Gwarko(ML)	149	5	84	18	142	0	77	8	0.58	3.16	0.78	2.77
4	Ekantakuna(ML)-Godawari	69	1	22	9	62	0	17	3	0.86	1.41	1.13	2.45
5	Lagankhel-Gwarko(SL)	24	2	25	0	19	0	19	0	1.08	2.00	1.28	0.00
6	Lagankhel-Godawari	97	3	29	1	92	0	23	0	0.51	2.45	1.18	1.41
7	Lagankhel-Ekantakuna	9	2	5	0	5	0	1	0	1.51	2.00	2.31	0.00
8	Gwarko(SL)-Ekantakuna(SL)	36	15	42	7	32	0	37	1	0.69	5.48	0.80	3.00
9	Gwarko(SL)-Godawari	73	0	38	6	69	0	32	1	0.47	0.00	1.01	2.67
10	Gwarko(ML)-Ekantakuna(ML)	192	5	97	8	187	0	92	1	0.36	3.16	0.51	3.30
11	Gwarko(ML)-Lagankhel	71	10	32	0	65	3	27	0	0.73	2.75	0.92	0.00
12	Godawari-Gwarko	115	0	60	4	107	0	57	1	0.76	0.00	0.39	1.90
13	Godawari-Lagankhel	300	4	77	1	292	0	72	0	0.46	2.83	0.58	1.41
14	Godawari-Ekantakuna	220	1	77	3	212	0	69	0	0.54	1.41	0.94	2.45

Note: SL-Service Lane, ML- Main Lane

10.2 Validation of travel time

For the validation of the travel time, the simulated travel time was again compared with the observed travel time field data. To check the accuracy of output, Normalized Root Mean Squared Error (NRMSE) was again used. Almost all the NRMSE values are found to be less than 0.30 except for Gwarko to Ekantakuna (Table 14).

Table 14. Validation of travel time

S.N	Vehicle Movement	Travel time		RMSE	NRMSE
		Observed	Stimulated		
1	Lagankhel to Godawari	25.54	18.066	7.474	0.292
2	Gwarko to Ekantakuna	35.91	16.58	19.33	0.538
3	Godawari To Lagankhel	37.42	25.41	12.01	0.320
4	Ekantakuna to Gwarko	17.51	15.47	2.04	0.116

11. Evaluation of Alternative Improvement

Two signal phases were initially planned, one with four-phase signal Planning on an existing case, resulting total cycle time of 342 sec, and another with the inclusion of a flyover resulting same cycle time of 342 sec, with a green time of 330 sec (on existing) and 333 sec (with flyover).

11.1 Analysis of queue length

It was observed that queue length was reduced by 100% while comparing existing cases and flyover cases in Gwarko and Ekantakuna. Similarly, queue length from Lagankhel to Godawari was reduced by 25% as shown in Table 15.

Table 15. Comparison of queue length

S.N.	Movement	Queue Length		% Change in Queue Length
		Existing	Flyover	
1	Ekantakuna(Sl)-Gwarko(SL)	22.11	0	100%
2	Ekantakuna(SL)-Lagankhel	7.44	0	100%
3	Lagankhel-Godawari	54.21	40.56	25%
4	Lagankhel-Ekantakuna	53.56	39.54	26%
5	Lagankhel-Gwarko(SL)	26.29	13.42	49%
6	Gwarko(SL)-Godawari	4.37	0	100%
7	Gwarko(SL)-Ekantakuna(SL)	26.68	0	100%
8	Godawari-Ekantakuna	22.35	6.36	72%
9	Godawari-Gwarko	55.21	32.7	41%
10	Godawari-Lagankhel	54.48	31.96	41%
11	Ekantakuna(ML)-Godawari	82.37	50.43	39%
12	Ekantakuna(ML)-Gwarko(ML)	82.55	-	0%
13	Gwarko(ML)-Ekantakuna(ML)	117.65	-	0%
14	Gwarko(ML)-Lagankhel	118.76	25.43	79%
	SL – Service Lane, ML – Main Lane			

11.2 Analysis of delay

The simulated stop delay of the existing case was compared with the flyover and it was observed that stop delay on Ekantakuna to Gwarko was reduced by 100% as shown in Table 16. Queue delay from both Gwarko and Ekantakuna was reduced by 99% (Table 17). While analyzing the vehicle delay, it was observed that vehicle delay was reduced by 94% (Table 18) on Ekantakuna (SL) –Gwarko (SL).

Table 16. Analysis of Stop Delay

S.N.	Movement	Stop delay		% Change in Delay
		Existing	Flyover	
1	Ekantakuna (SL) –Gwarko (SL)	66.2	0	100%
2	Ekantakuna (SL)- Lagankhel	0	0	-
3	Lagankhel – Godawari	118.11	119.68	-1%
4	Lagankhel – Ekantakuna	137.18	99.79	27%
5	Lagankhel - Gwarko (SL)	0.06	0.1	-67%
6.	Gwarko(ML)-Lagankhel	122.29	48.26	61%
7	Gwarko(ML)- Ekantakuna(ML)	121.13	-	-
8	Godawari – Ekantakuna	0.67	0.14	79%
9	Godawari- Gwarko	101.01	90.67	10%
10	Godawari- Lagankhel	101.92	114.62	-12%
11	Ekantakuna(ML) – Godawari	97.93	38.97	60%
12	Ekantakuna(ML)- Gwarko	86.46	-	-
13	Gwarko(SL)-Ekantakuna(SL)	91.55	0.05	100%
14	Gwarko(SL)- Godawari	0.14	0.07	50%
	Note: SL-Service Lane, ML- Main Lane			
	Average	74.61	36.59	51%

Table 17. Analysis of change in Queue Delay

S.N.	Direction	Existing	Flyover	% Change in Delay
1	Ekantakuna	63.06	0.9	99
2	Godawari	as41.34	24.71	40
3	Lagankhel	90.79	28.8	68
4	Gwarko	30.97	0.24	99

Table 18. Analysis of change in Vehicle Delay

S.N.	Movement	Vehicle Delay		% Change in Delay
		Existing	Flyover	
1	Ekantakuna(SL)-Gwarko(SL)	79.08	5	94%
2	Ekantakuna(SL)-Lagankhel	0	0.33	-
3	Lagankhel-Godawari	146.97	153.85	-5%
4	Lagankhel-Ekantakuna	154.77	124.45	20%
5	Lagankhel-Gwarko(SL)	6.39	52.99	-729%
6	Gwarko(ML)-Lagankhel	140.91	56.98	60%
7	Gwarko(SL)-Ekantakuna(SL)	147.33	-	-
8	Godawari-Ekantakuna	11.2	37.18	-232%
9	Godawari-Gwarko	117.97	111.17	6%
10	Godawari-Lagankhel	118.17	126.09	-7%
11	Ekantakuna(ML)-Godawari	121.45	59.33	51%
12	Ekantakuna(ML)-Gwarko(ML)	108.19	-	-
13	Gwarko(ML)-Ekantakuna(ML)	110.33	0.05	100%
14	Gwarko(SL)-Godawari	13.57	0.07	99%
	Note: SL-Service Lane, ML- Main Lane			
	Average	**91.16**	**51.96**	43%

11.3 Analysis of level of service (LOS)

LOS on existing case was observed worst due to high traffic volume and more delay on road i.e, LOS_F in most cases. Comparing both scenarios (existing and with flyover) major improvement was observed in Ekantakuna to Gwarko route (Table 19). There were no improvements in Godawari to Lagankhel, Godawari to Gwarko, Lagankhel to Godawari and Lagankhel to Ekantakuna routes.

Table 19. Analysis of LOS

S.N.	Movement	Los	
		Existing	Flyover
1	Ekantakuna(SL)-Gwarko(SL)	Los_E	Los_B
2	Ekantakuna(SL)-Lagankhel	Los_A	Los_A
3	Lagankhel-Godawari	Los_E	Los_E
4	Lagankhel-Ekantakuna	Los_F	Los_F
5	Lagankhel-Gwarko(SL)	Los_A	Los_D
6	Gwarko(ML)-Lagankhel	Los_B	Los_B
7	Ekantakuna(ML)-Godawari	Los_F	Los_E
8	Gwarko(SL)-Godawari	Los_B	Los_A
9	Gwarko(SL)-Ekantakuna(SL)	Los_F	Los_A
10	Godawari-Ekantakuna	Los_F	Los_D
11	Godawari-Gwarko	Los_F	Los_F
12	Godawari-Lagankhel	Los_F	Los_F
13	Ekantakuna(ML)-Gwarko(ML)	Los_F	-
14	Gwarko(ML)-Ekantakuna(ML)	Los_E	-
	Note: SL-Service Lane, ML- Main Lane		
	Average	**Los_E**	**Los_D**

12. Conclusion and Recommendation

The study demonstrated that introducing a flyover along the Satdobato–Ekantakuna corridor could bring noticeable improvements to the area's traffic conditions. Under the current situation, the Level of Service (LOS) during the morning peak hour was classified as E, indicating heavy congestion and long delays. With the proposed flyover in place, the LOS improved to D, suggesting more manageable traffic flow and reduced congestion.

Adjustments to signal timings also had a considerable impact on traffic movement. On the Godawari to Ekantakuna route, the stop delay decreased by 79%, meaning vehicles spent significantly less time waiting at intersections. However, on the Godawari to Lagankhel route, the stop delay increased slightly by 12%, pointing to the need for further fine-tuning of signal coordination in nearby areas. In terms of vehicle delays, the Godawari to Lagankhel direction saw a minor increase of 7%, while the Lagankhel to Ekantakuna route experienced a noticeable 20% reduction. Traffic speeds also improved substantially, with an 81% increase at the Ekantakuna approach, reflecting smoother and quicker vehicle movement through this section. Queue conditions improved as well. The queue delay from Ekantakuna to Gwarko was completely eliminated, while the queue length from Lagankhel to Godawari was reduced by 25%. These changes indicate a more efficient flow of traffic, especially in areas that previously faced significant bottlenecks.

Overall, the analysis confirmed that the Satdobato intersection currently experiences heavy traffic congestion, particularly during peak hours. The proposed flyover appears to be a practical solution to this problem. By allowing uninterrupted movement for vehicles along key routes and reducing conflict points at intersections, the flyover is expected to ease congestion, shorten travel times, improve speeds, and minimize delays. In addition, it would enhance the capacity of the road network, enabling it to handle higher traffic volumes more effectively in the future. In summary, both the proposed flyover and signal adjustments show promise in addressing existing traffic issues along the corridor. If implemented carefully, these improvements could lead to safer, faster, and more reliable traffic conditions in the area.

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