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Design of Cycle Track and Performance Analysis Using VISSIM Simulation Software at an Uncontrolled Intersection-DVS Circle in Shivamogga City

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Abstract: *Proper design of cycle track enables to reduce conflicts between other motorists and it also ensures the safety of cyclists. It has more beneficiary advantages like health, reduction in traffic jams, saving fuel costs, eco mobility transport, environmental friendly etc. The properly designed cycle track provides the travel pattern of motorized as well as nonmotorized vehicles without causing disturbance to large and high speed moving vehicles and also helps in encouraging the bicycle users more. The paper focuses on design of cycle track along with performance analysis using simulation software VISSIM for DVS circle, an uncontrolled intersection in Shivamogga city of Karnataka state. Site reconnaissance survey and traffic survey were carried out and the data were used for the design of cycle track and also given as input for the VISSIM software. Precise output was drawn from the software after calibration. This was compared with the field data. Vehicle flow and mean speed of the mixed traffic were selected as the parameters for checking the performance using VISSIM software. Before calibration, VISSIM software underestimated the volume and overestimated the mean speed of the mixed traffic. Simulated traffic volume was seen very less in all the roads. Design of the cycle track was done using IRC:11-2015 code book. Comparing the simulation result of both the systems i.e. open type cycle track system and dedicated separate cycle track system, GEH value was less for later case for simulated volume indicating the higher volume output for the same set of calibrated values. So it was observed that, if the cycle traffic operates with the motor traffic, the capacity of the study area was reduced. Hence it is feasible to adopt 'Dedicated Separate Cycle Track System' for efficient and safe operation of the traffic on the study area.*

Keywords: *Cycle track, Simulation, VISSIM*

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I. Introduction

Bicycles are the low cost and easiest form of transport mode that is used to reduce environmental pollution and to use as ecofriendly. For the low income countries, especially like India the developing country, bicycles offers a good option to use when it becomes difficult to use motorized vehicles. Cycling is amongst the most sustainable modes of mobility, which has zero dependence on fossil fuels and zero emissions unlike the motorized modes of transport, which have huge negative externalities, namely- accidents, congestion, fossil energy use, and environmental degradation. Cycling, in fact, is associated with positive externalities like health improvements, congestion reduction, lessening of air pollution and greenhouse gas (GHG) emissions, and minimizing energy use. In addition to these positive impacts, in the context of a developing country like India, cycling presents the most affordable and efficient means of travel for low-income households who find it difficult to afford most motorized transport options[1,2]. Srivastava et al. (2017) studied about analysis of bicycle usage in India with an environmental perspective and it was concluded that there must be awareness given to the public regarding the usage of bicycle more than motorized traffic [3].Vassi.C and Vlastos. T (2014) studied about critical assessment of cycling infrastructures across Europe. It was concluded that cycling infrastructure influenced by many factors such as land use planning, car parking, car free zones and speed limits [4].Dey et al. (2018) carried out calibration and validation of VISSIM model of an intersection with modified driving behavior parameters. GEH statistics measure was adopted to measure the level of calibration of the software. GEH value of the microscopic model was 2.863 which indicated a well calibrated model and represented the field traffic condition with remarkable accuracy [5].Manzoor et al. (2018) carried out characterization of parameters to mitigate urban traffic congestion using VISSIM software. From the analysis of the data, it was found that: The parameters Average Standstill Distance and Headway Speed were found to be the most crucial with regard to calibration of the model [6].

II. Methodology

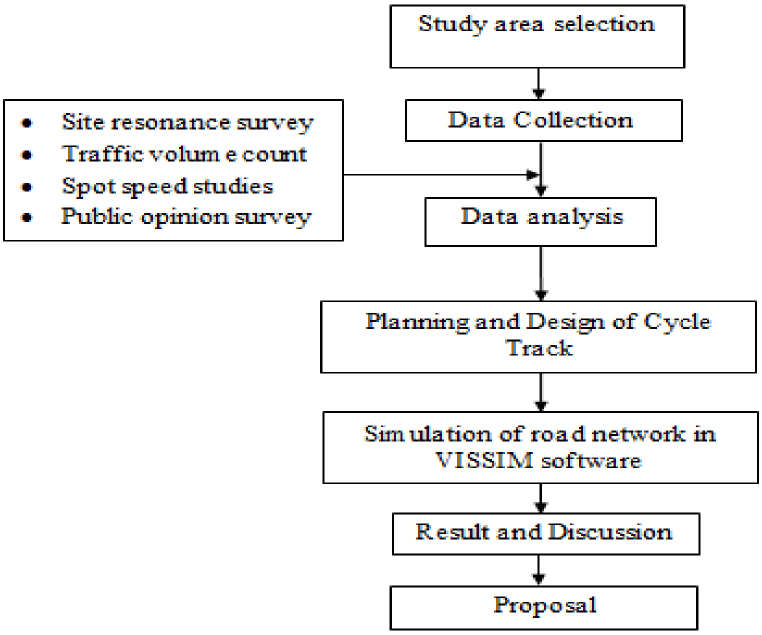

Fig.1. Methodology adopted for the study.

The methodology for the present study consists of selection of study area. Main criteria adopted for selection of study area was, more number of cycle traffic. In Shivamogga city more of cycle users are students. Hence a study area was selected where more number of educational institutions were seen. Taking this into consideration 'DVS Circle' was selected for the work. Then the data collection process was started. Site reconnaissance survey and traffic surveywere carried out. Analysis of the data was done and the major conclusions were drawn. Based on the data analysis results planning and design of the work was made. Required input for the VISSIM software for simulation was generated. Precise output was drawn from the software after calibration.

III. Study Area and Data Collection

3.1 Study Area

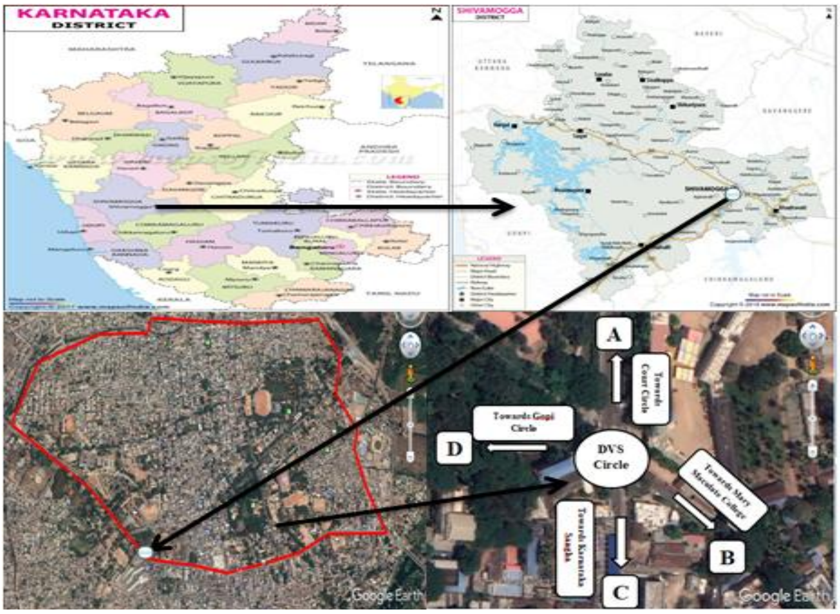

Fig.2. Study Area.

The study is conducted in Shivamogga district of Karnataka. A four legged uncontrolled intersection was selected.The study area ‘DVS Circle’ was selected because it is being one of the places where more bicycle traffic is seen. Also the reason for more number of bicycle traffic is because of the number of educational institutions nearby.

3.2 Data Collection

Field data is collected by conducting three survey’s namely, site – reconnaissance survey, traffic survey and public opinion survey. The data collected from the above said surveys are analyzed and taken into consideration for planning and design of cycle tracks.

3.2.1 Site-Reconnaissance Survey

The information collected were type of road, number of lanes, carriageway type, width of Carriageway, shoulder type, width of shoulder, width of median etc.

Road A is a divided carriageway road with 2 lanes in each direction and is with 1m median.Existing carriageway width is 9m. Existing Right of Way is 26m.Unauthorized road side vendors with temporary shops were observed. There are existing trees on either side of the road. Paved shoulder of 0.5 m width in each direction. A wide paver blocks footpath is present with width of 3 m in each direction.Road B is an undivided carriageway road with carriageway width of 8 m. Average available Right of Way is 12 m.Paved shoulder of 1 m width is seen in both direction. Road C is an undivided carriageway road with carriageway width of 7 m. Average available Right of Way is 12 m.Unpaved shoulder of 1 m width is seen in both direction. Road D is an undivided carriageway road with carriageway width of 7 m. Average available Right of Way is 12 m.Paved shoulder of 0.5 m width is seen in both directions. All the roads are having Storm Water Drains on either side of the road which are in good condition and here are several Utilities along the road side, such as Electrical lines, OFC’s buried underground.Unauthorized road side vendors with temporary shops were observed. There are existing trees on either side of the roads. Parking facilities and cycle track facilities are absent on all the roads.

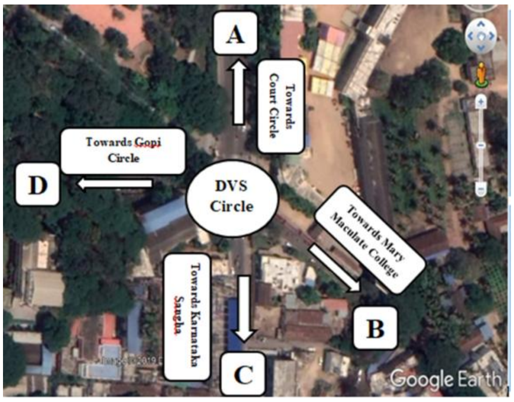

Fig.3. Uncontrolled Intersection Selected for the Study

Fig.4. Roads A, B, C and D of the selected Intersection

3.2.2Turning Volume Count Survey

The survey was conducted on a typical weekday. The data was collected for four hours from 8 : 00 AM to 10 : 00 AM and 4.30 PM to 6.30 PM. The vehicles were classified into six categories and data was collected namely: Cars, motorized two wheelers, light commercial vehicles, buses, auto rickshaws and bicycles. Video graphic survey was conducted by capturing the traffic flow by camera. Camera position was properly placed so that to record the number of vehicles by category covering all directions of traffic flows. The counts were recorded at ten minute intervals Manual counts are carried out by vehicle type. Morning and evening peak 10 minutes data was identified and is given as input for the VISSIM software for calibration and validation process respectively.

Table 1. Turning Volume Count at DVS Circle

From	To	MTW	Cars	AU	LCV	Bus	CY
	B	66	32	12	6	3	13
	C	72	2	18	2	0	0
A	D	16	2	0	0	1	4
	Inflow at A	**92**	**54**	**22**	**0**	**5**	**18**
	Outflow at A	**154**	**36**	**32**	**8**	**4**	**17**
	A	14	4	4	0	4	16
	C	6	4	2	0	0	0
B	D	28	0	2	0	0	2
	Inflow at B	**131**	**42**	**15**	**6**	**3**	**22**
	Outflow at B	**48**	**8**	**8**	**0**	**4**	**18**
	A	44	40	12	0	0	0
	B	17	2	1	0	0	2
C	D	22	8	10	0	0	0
	Inflow at C	**92**	**8**	**24**	**2**	**0**	**0**
	Outflow at C	**73**	**50**	**28**	**0**	**0**	**2**
	A	34	10	6	0	1	2
	B	58	8	2	0	0	7
D	C	14	2	4	0	0	0
	Inflow at D	**66**	**10**	**14**	**0**	**1**	**6**
	Outflow at D	**106**	**20**	**12**	**0**	**1**	**9**

Table 2. Turning Volume Composition at DVS Circle

Road	Traffic	Vehicle Composition (%)					
		MTW	Car	AU	LCV	Bus	CY
A	Inflow	48	28	12	0	3	9
	Outflow	61	14	13	4	2	6
B	Inflow	60	19	7	3	1	10
	Outflow	56	10	10	0	5	19
C	Inflow	73	6	19	2	0	0
	Outflow	49	34	16	0	0	1
D	Inflow	67	11	15	0	1	6
	Outflow	72	14	3	0	0	6

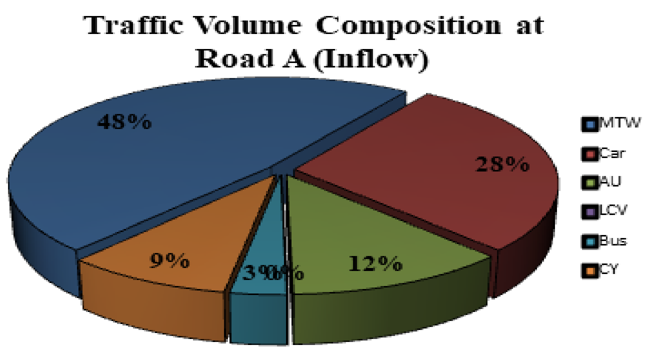

Fig.5. Traffic Volume Compositiion at Road A(Inflow)

3.2.3Spot Speed Study

Spot speed study methodology was done to collected speed data of different types of vehicles. Spot speed study has to be conducted for the information regarding desired speed of each mode using the selected link. Sampling technique was adopted. Total possible samples are collected within one hour and this data is used for calibration and validation process of the VISSIM software. Mean speed, maximum speed, minimum speed observed of individual vehicles is presented in Table 3. For mixed traffic the mean speed observed was 12 kmph was on roads A and B and 7 kmph on roads C and D. It can be observed that higher speed was seen on roads A and B compared to roads C and D. This was because, roads A is a divided carriageway road and road B is one way traffic road. Roads C and D were undivided two way traffic carriageway roads.

IV. Discussion

4.1 Design

IRC: 11-2015 was adopted for the design of cycle track and the result is shown in Table 4.Painted cycle lane infrastructure was adopted on the edge of the carriageway, adjacent to the footpath or parking with a gradient of 1:20 and lane width of 1 m to 1.2 m. Radius of horizontal curve and stopping sight distance were measured using design speed adopted.

Table 3. Spot Speed Survey Result

Vehicle Category	Speed (km/h)				
	Mean Speed	Max Speed	Min Speed	15 th percentile speed	85 th percentile speeed
Car	23	41	15	16.7	31.8
MTW	25.8	42	12	16.7	36.5
LCV	25	32	12	15	26.2
Bus	25	28	10	3	23
Auto	25	32	10	16	29.5
Cycles	7.2	12	5	5	9.5

Table 4. Cycle infrastructure Design adopted as per IRC:11-2015

	Road A	Road B	Road C	Road D
Cycle type	Adult touring cycle			
Cycle infrastructure	Srggregated Cycle Trtack	Cycle lane	Cycle lane	Cycle lane
Location	On the edge of the carriageway, adjacent to the footpath or parking.			
Design speed	12 kmph	12 kmph	7 kmph	7 kmph
Gradient(Min)	1:20	1:20	1:20	1:20
Lane Width	1.2 m	1 m	1 m	1 m
Radius of Curves	5.5 m	5.5 m	1.5 m	1.5 m
Stopping Sight Distance	12 m	12 m	6 m	6 m

4.2 Development of Simulation Model using VISSIM software

Simulation techniques can be used to know the vehicular behavior on the network which helps in analysis and design of the road network for the effective and efficient working of the traffic pattern inside the network. First stage of the simulation modeling is to provide the necessary input for the software. This includes field data which in turn includes geometric details of the roads and survey data related to vehicles. After giving all the inputs to the software, the simulation is run with the default values of the driving behavior parameters. Traffic volume and mean speed of the vehicles is taken as output. This result is compared with the actual field data. In general VISSIM in its default run will not produce the satisfactory results; hence calibration of the model should be done with proper methodology.

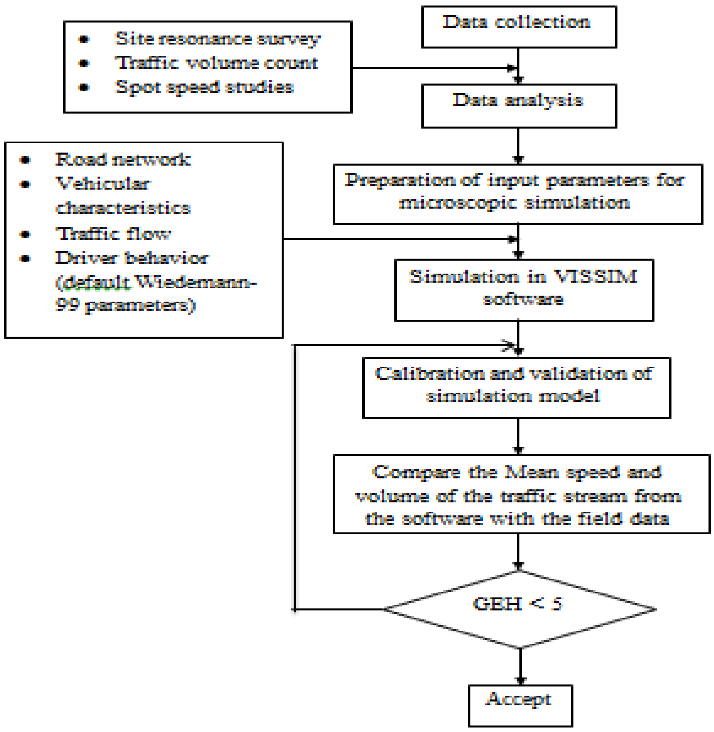

Fig.6. Methodology adopted for the simulation.

Fig.7. Base Link input in VISSIM

Table 5. Vehicle Acceleration, Deceleration and Lateral Clearance Data Given as Input in VISSIM **(Source: Mehar et al., 2014)**

Vehicle Category	Acceleration (m/s^2)		Deceleration (m/s^2)		Lateral-Clearance (m)	
	Max	Desired	Max	Desired	Min	Max
Car	2.7	1.3	1.8	1.2	0.3	0.5
MTW	2.5	1.5	1.7	1.2	0.1	0.3
LCV	2.7	1.6	1.7	1.2	0.3	0.5
Bus	2.2	1.6	1.5	0.5	0.3	0.6
Auto	2.5	1.5	1.7	1.2	0.3	0.5

4.2.1 Calibration of the Model : (GEH Statistics)

Traffic conditions in India are entirely different from those exists in the USA and European countries. The VISSIM is not developed for the traffic conditions prevailing in India and hence it should be calibrated.Geoffrey E. Havers developed a continuous volume tolerance formula while working as a transport planner in London, England in the 1970s. Although its mathematical form is similar to a chi-squared test, is not a true statistical test. Rather, it is an empirical formula that has proven useful for a variety of traffic analysis purposes. For hourly traffic flows, the GEH formula is:

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

Where: m is the values from the traffic model (per hour) c is the real-world traffic value (per hour) For traffic modeling work in the "baseline" scenario, a GEH of less than 5.0 is considered a good match between the modeled and observed hourly volumes (flows of longer or shorter durations should be converted to hourly equivalents to use these thresholds). According to DMRB, 85% of the volumes in a traffic model should have a GEH less than 5.0. GEHs in the range of 5.0 to 10.0 may warrant investigation. If the GEH is greater than 10.0, there is a high probability that there is a problem with either the travel demand model or the data. Simulation results should within an acceptable range of values using the GEH statistic. The GEH Statistic is used to compare observed volumes with those obtained from simulation results.

Trial and Error method was adopted for calibration process of the software by varying different parameters (network parameters and driving behavior parameters). Simulation was carried out for mixed traffic condition with sufficient input data and with default values of the parameters in the software. Then both the driving behavior parameters and network parameters are varied by assuming suitable range and the mean volume data was obtained. This was again compared with the field data and the process was continued until GEH was less than 5. For the same calibrated values simulation was continued using another set of field data. If the GEH value was less than 5, then the model was ready for obtaining precise real time output.

4.2.2 Validation of the Model

Validation of the simulated model is done to check the reliability of the model for the said objectives and aims. Validation process is same as the calibration process. Only difference from calibration process is, the data set should be different

4.2.3 Results Generated by VISSIM

Before calibration i.e with the default driving behavior parameters run, the VISSIM software underestimates the volume. Simulated traffic volume was seen very less in all the roads. There was a large variation between field and simulated result. GEH value of 9 to 11 range was seen which shown high instability in the output data. After calibration the GEH values reduced to a value below 5 which shown reliable data. A check for the reliability of the data was done by considering another set of field data i.e. validation check, result shown that the model with calibrated values was reliable to take the results for analysis and design. Original field data i.e. existing system (open type cycle track system) is taken for calibration of the software. Comparing the simulation result of both the systems i.e. open type cycle track system and dedicated separate cycle track system, GEH value was less for later case for simulated volume indicating the higher volume output for the same set of calibrated values. So it was observed that,if the cycle traffic operates with the motor traffic, the capacity of the study area was reduced. Hence it is feasible to adopt ‘Dedicated Separate Cycle Track System’ for efficient and safe operation of the traffic on the study area.

Table 6. Calibrated Values of Driving Behaviour Parameters

Driving Behaviour Parameter	**Default Value in the software**	**Calibrated Value**
Stand still distance	1.5 m	0.25 m
Headway time	0.9 s	0.1 s
Observed vehicles	4	2
Look ahead distance		
Minimum	0 m	50 m
Maximum	250 m	250 m
Look back distance		
Minimum	0 m	50 m
Maximum	150 m	150 m
Minimum headway	0.5 m	0.1 m
Waiting time before diffusion	60 s	120 s
Minimum Lateral distance		
At 0 kmph	0.2 m	0.1 m
At 50 kmph	1 m	0.2 m
Desired lateral position at free flow	Middle of lane	Left of the lane

Table 7. Field and Simulated Volume Result of Open type Cycle Track System (For Calibration)

Roads	Inflow of Vehicles for 10 minutes for Open type Cycle Track System				
	Before calibration			After calibration	
	Field Observation	Simulated Result	GEH	Simulated Result	GEH
A	209	94	9.34	157	3.84
B	241	123	8.75	191	3.4
C	126	33	10.43	79	4.64
D	103	18	10.93	57	5.14

Table 8. Field and Simulated Volume Result of Dedicated Separate Cycle Track System

Roads	Inflow of Vehicles for 10 minutes by Separating Cycle Traffic (Dedicated Separate Cycle Track)		
	Field Observation	Simulated Result	GEH
A	191	169	1.64
B	219	177	2.98
C	126	82	4.31
D	97	55	4.82

Table 9. Field and Simulated Volume Result (Validation)

Roads	Inflow of Vehicles for 10 minutes		
	Validation of the model		
	Field Observation	Simulated Result	GEH
A	213	189	1.69
B	194	172	1.63
C	121	87	3.33
D	95	59	4.1

V. Conclusion

By considering results from simulation software VISSIM and design criteria from IRC: 11-2015, roads A of the intersection in the study area was designed for separate dedicated cycle lane of width 1.2 m and roads B, C, D were designed for dedicated cycle track of width 1 m. Painted cycle lane infrastructure was adopted on the edge of the carriageway, adjacent to the footpath or parking with a gradient of 1:20. Radius of horizontal curve and stopping sight distance were calculated using design speed adopted and it was found to be 5.5m and 12m respectively for a design speed of 12kmph for roads A and B, and 1.5m and 6m for a design speed of 7 kmph for roads C and D.Simulation using the software was done considering only 10 minutes data. The work can be extended for giving input of one hour data to the software and analyzing the output, this increases the accuracy of the result.

References

[1]. IRC : 11-1962, Recommended Practice for the Design and Layout of Cycle Tracks.

[2]. IRC : 11-2015, Recommended Practice for the Design and Layout of Cycle Tracks.

[3]. Akash Krishna Srivastava, Shashank Mishra and DebalinaChakravarty.,Analysis of Bicycle Usage in India: An Environmental Perspective, *International Journal of Innovations & Advancement in Computer Science (IJIACS)*, 6(8) 2017.

[4]. Vassi. A and Vlastos. T., A review and critical assessment of cycling infrastructures across Europe, *The Sustainable City IX*, 2014, 757-760.

[5]. C. Dey, S. Roy and M. A. Uddin., Calibration And Validation Of Vissim Model Of An Intersection With Modified Driving Behavior Parameters, *International Journal of Advanced Research (IJAR)*, 2018, 107-112.

[6]. ManzoorElahi, Rawid Khan, Anwar Ali , M Tariq Khan and Bashir Alam., Characterization of Parameters to Mitigate Urban Traffic Congestion in Developing Countries–A Case Study of Peshawar Pakistan, *International Journal of Advance Engineering and Research Development (IJAERD)*, 5(2), 2018.

[7]. ArpanMehar, Satish Chandra, and S. Velmurugan., Highway Capacity Through Vissim Calibrated for Mixed Traffic Conditions, Korean Society of Civil Engineers (KSCE), 2014, 639-645.

[8]. John Pucher and Ralph Buehler., Cycling towards a more sustainable transport future, *Transport Reviews*, 37(6),2017, 689–694.

[9]. Tomas U. Ganiron Jr., Effect of Bike Lane Infrastructure on Ridership, *World Scientific News 74*, 2017, 36-52.

[10]. Anne C Lusk, Peter G Furth, Patrick Morency, Luis F Miranda-Moreno, Walter C Willett and Jack T Dennerlein., Risk of injury for bicycling on cycle tracks versus in the street, *BMJ Journals*, 2019, 131-135.

[11]. Yanli Wang, Liang Li, Xiaoyu Zhu, Bing Wu and Linbo Li., Evaluation of Urban Redevelopment Impact on Non-Motorized Traffic, *Journal of Traffic and Transportation Engineering*, 2015, 187-197.

[12]. Todd Litman., Quantifying the Benefits of NonmotorizedTransportation For Achieving Mobility Management Objectives, *Victoria Transport Policy Institute*, 2009, 134-140.

[13]. Michael Trueblood and Jim Dale., Simulating Roundabouts With VISSIM", *2nd Urban Street Symposium*, 2003.

[14]. PTV.VISSIM 10 User Manual. Karlsruhe, Germany, 2018.

[15]. Victor Andrade Danish , Ole B. Jensen and Henrik Harder., Bike Infrastructures and Design Qualities: Enhancing Cycling, *Journal of Geoinformatics and Land Management*, 2011, 65-80.

[16]. Ralph Buehler and Jennifer Dill., Bikeway Networks: A Review of Effects on Cycling, *Transport Reviews*, 2015, 122–148.

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