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Modification of Major Intersections in Urban Area of Sialkot City, Pakistan

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ABSTRACT

Traffic management is a major problem in large cities of Pakistan. Pakistan is a developing country with aging infrastructure of roadways and railways. The traffic conditions are deteriorating due to inappropriate design. Traffic problems due to improper design have resulted in loss of the life and property. The main purpose of this study is to identify the existing traffic condition of Sialkot City, Pakistan at Daska, Model Town Bhed Puli and Gulistan Cinema intersection. The Sialkot City is connected with Narowal, Gujrat and Gujranwala through Metalled streets. Sixteen hours of Manual Traffic Count was conducted at each intersection. Equivalent factors for Passenger Car Unit recommended by Government of Punjab are used. Afterwards, analysis has been carried out using Signalized and unsignalized Intersection Design and Research Aid (SIDRA) software. It is observed that Level of Service (LOS) is poor and Volume Capacity Ratio (V/C) is higher for the selected intersections. In order to eliminate the issues of the selected intersection, a few enhancements are suggested and are described in detail. LOS is improved by provision of signals for Gulistan Cinema intersection and Model Town Bhed Puli intersection along with separation of slow moving vehicles by providing service lane; whereas for Daska intersection, freeway provided for traffic channelization with provision of bus bay and parking lane.

Keywords: Degree of Saturation, Level of Service, Intersections, Traffic count, Highway, Volume Capacity Ratio

1. INTRODUCTION

The objective of an efficient transportation system is to identify its main characteristics that depend on demand of services required. Transportation system has impact on economy, society, environment and social life. The consideration of such factor in transportation system design has considerably gained importance in recent year due to economic and social development of our civilization. The primary objective of such configuration is to encourage efficient drive of vehicles and street clients through the crossing points in a mechanized manner. The coordination among neighboring cities about effective land use is necessary as traffic is not confined within city boundaries. The planning of transportation system of a city must include provision of motorized and non-motorized transport options. The population of major cities of Pakistan including Gujranwala and Sialkot is increasing. Effective transportation system within these neighboring cities will plays a key role in their industrial development. Traffic congestion is a major problem in developing cities. It also affects the GDP at national and international level. Transportation planning is an important consideration while considering plans for improving the quality of life and growth of cities [1]. Socioeconomic statues

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have impacts on transportation system opted in cities. It is observed that highways have facilitative association with both education and income [2]. The time expenditure is an important indicator about effectiveness of public transport vehicles as compared with individual vehicles [3]. The design of transportation system not only depends on the efficiency but also on implication of resilience. Resilience is defined as recovery of a system from disruptions. It was found by the researchers that inefficient roadways systems operating at normal load are resilient to disruption [4].

In developed countries, per capita emission from the transportation can be upto four times higher for less density urban areas as compared with higher density areas. It is mainly due to provision of effective transportation system in higher density areas that also encourages people to use non-motorized system such as use of bicycle or walking because of restriction in car use and limit on parking space [5]. Mexico City was once world most polluted city. The City management has implemented 15-year plan to reduce the carbon dioxide emission. Effective transportation system and mobility is one of the seven pillars of Plan Verde [6]. In 2007, New York has initiated a plan (PlaNYC) to make New York a more sustainable City by 2030 [7]. The New York City has managed to add more than 200 miles of bicycle lanes and a bus rapid transit line.

In Pakistan, vehicles run mostly on either petrol or diesel. The carbon dioxide emission from these vehicles is polluting our environment. Many developed countries are adopting electric vehicles to counter such problems. South Korea has initiated a Smart Grid Road Map that also includes increase in use of electric vehicles by 2030 [8]. The performance of traffic can be improved by coordinating signals at road intersections. Geometric delays must be considered while computing delays in peak hours. SIDR software is used by researchers for studying the improvement in level of service at intersections [9]. The efficiency of transportation system is generally accessed through the ease of vehicle and congestion situation; however, the mileage efficiency can have impact on net benefits of the transportation system [10]. Efficient transport doesn't mean to have more lanes for traffic but to utilize the lesser lane in an efficient way. Efficient system will help in reducing the need for massive investment in highway and airports [11].

The fundamental goal of this investigation was to evaluate existing and potential future traffic activities at Gujranwala; resulting from traffic coming from Sialkot. The traffic coming from Sialkot City mostly goes through Gulistan Cinema, Model Town and Daska intersection before entering Gujranwala. Every crossing point was investigated utilizing the product SIDRA. Equivalency factors recommended by Government of Punjab [12] were used to convert the volume into Passenger Car Unit (PCU). Level of Service (LOS) of the intersection are computed using Volume Capacity Ratio (V/C) model [13]. The potential future crossing point enhancements are suggested.

Sialkot city population is about 0.809 million and is developing at rate of 2.21 percent per annum. It is estimated that its population will reach to 1.398 million by 2035. Sialkot city is connected with neighboring urban communities and towns through provincial street system and rail lines. Its Dry port and International Airport have contributed towards its monetary development. Sialkot has seen increase of 17 percent vehicles in recent five years. At present, in excess of 250,000 vehicles are enrolled in the area. The rise in number of vehicles has resulted in traffic jams in many areas on daily basis [14].

The previous studies about transport facilities in Sialkot city show that the use of public transport is very less as compared with other modes of transport in the City. The transport in Sialkot mostly passes through a single corridor in the City due to unique alignment of road network. It resulted in congestion of road due to heavy traffic flow [15].

The manual traffic count at the intersections have revealed that Daska and Gulistan Cinema intersection are critical intersections because of heavy traffic and low standard of level of service. Daska intersection is very important because all the traffic which enters in the City passes through this intersection. Gulistan Cinema Intersection is also important because of Lorry Adda and Airport.

Daska Intersection is the first intersection coming from neighboring city of Gujranwala. It is a three legged intersection which connects the Daska to Sialkot city. Model Town Bhed Puli intersection is also a three legged intersection that connects Wazirabad Road to Alam Intersection and Khawaja Safdar Road. Gulistan Cinema intersection is four legged and it connects Lorry Adda to Airport road, Wazirabad and Alam intersection. Study area and satellite map of selected intersection is shown in Fig. 1, 2, 3 and 4.

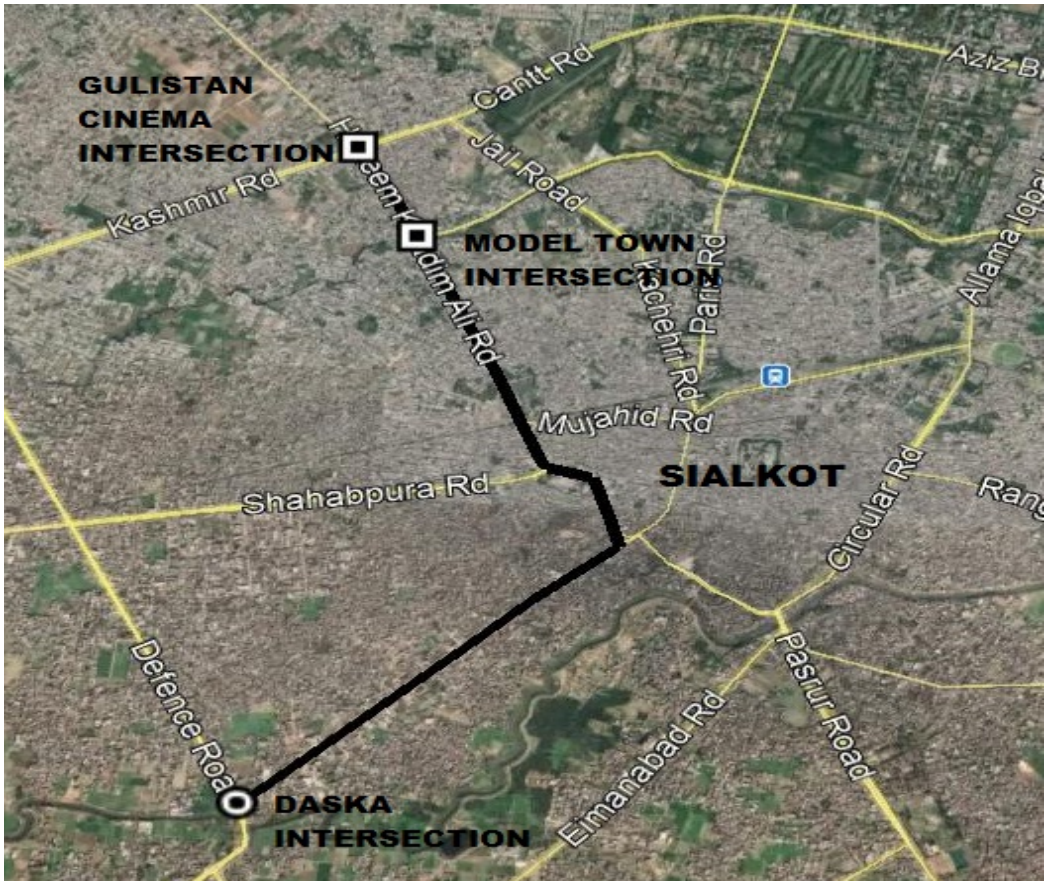

Fig. 1: Study Area (Intersections)

Fig. 2: Model Town Intersection

Fig. 3: Daska Intersection

Fig. 4: Gulistan Cinema Intersection

There are many software's which can be used to estimate the level of service and degree of saturation. The Signalized and Unsignalized Intersection Design and Research Aid (SIDRA) Software is a convergence based Software created by the Australian Road Research Board (ARRB) in Australia as a guide for limit, timing and execution examination of disengaged crossing points. SIDRA is a ground-breaking logical program for signalized crossing points [16]. SIDRA programming is utilized as a guide for structure and assessment of signalized crossing point (fixed-time/pre-coordinated and impelled), roundabouts, two-way stop sign control, all-way stop sign control, and giveway (yield) sign-control [17].

2. METHODOLOGY

Different tasks were performed for data collection. The task also includes collection of existing road network available information and transportation facilities. The traffic data were recorded manually and converted into PCU according Pakistan Geometric Design manual is given in Table 1.

Traffic date was recorded for 16 hours (7.00 AM to 11.00 PM). The performa used for manual traffic count is shown in Table 2. After traffic count, peak hour of each intersection is decided. Peak hour is selected based on traffic routine of the residents in the cities. Office timings are mostly from 8:00 AM to 4:00 PM and 2:00 PM to 3:00 PM is mostly the time at which educational institutes are closed. Peak hour for all the investigated intersections are given in Table 3.

Table 1: Passenger Car Unit (PCU)

Sr. No	Vehicle Category	PCU factor
1	Animal Driven Cart	5
2	Bicycle	0.3
3	Motor Cycle / Scooter	0.5
4	Rickshaw / Qingqi	0.8
5	Car/Taxi/Suzuki Pickup/Loader	1
6	Jeep / Pajero	1.5
7	Hiace / Wagon	1.5
8	Medium Bus / Flying Coach	2.5
9	Bus	3
10	Loader Pickup	1.5
11	2-Axle Truck	4
12	3-Axle Truck	4
13	4-Axle Truck	4
14	5-Axle Truck or Above	5
15	Tractor Trolley	4

Table 2: Performa for Traffic Count

SIALKOT MANUAL TRAFFIC COUNT DATA

Point No. _____ Date _____

Location _____ Weather _____ Temperature _____ Day _____

Direction from _____ to _____

Sr. No	Mode / Time Span	Car /Jeep	Motor Cycles	Rickshaw	Buses	Mini-Buses	Toyota Wagon /Taxi	Suzuki Van	Truck/ Tractor Trolles	Bicycle	Total
1	0700~0715										
2	0715~0730										
3	0730~0745										
4	0745~0800										
5	0800~0815										
6	0815~0830										
7	0830~0845										
8	0845~0900										
9	0900~0915										
10	0915~0930										
11	0930~0945										
12	0945~1000										
13	1000~1015										
14	1015~1030										

Table 3: Peak Hourly PCU

Intersection	Peak Hour	Volume of traffic (PCU)
Daska Intersection	8:00 AM to 9:00 AM	9232
Model Town Intersection	2:00 PM to 3:00 PM	6577
Gulistan Cinema Intersection	4:00 PM to 5:00 PM	15141

Topography of all three selected intersection were mapped; and natural and manmade features which include telephone pole, electric pole, culvert, shops, plazas, banks and mosque are marked. The traffic data count is analyzed for each fifteen minutes interval. The data then converted into hourly interval and peak hour of traffic flow for each intersection is determined. Afterwards passenger car units of each interval and percentage of vehicle, average daily traffic and peak hourly volume is determined. Finally, the directional distribution of peak hour for each direction of selected intersection is determined.

SIDRA software is used to find LOS. The peak hour is utilized for performing traffic examination in SIDRA. The investigation reveals traffic issue at crossing point. The growth rate is estimated by using past traffic as 2% [18] and degree of saturation is determined. If degree of saturation is increased in future, then modification of intersection and geometry is required. Selected intersections for this study are unsignalized. According to guidelines of Highway Capacity Manual [19], LOS results are compared to volume to capacity ratios and are given in Table 4.

3. RESULTS AND DISCUSSION

After the analysis of traffic count of the selected intersections, PCU is determined. PCU values are used in SIDRA software and level of service of the intersection is determined with respect to its degree of saturation. Growth rate is taken as 2%. LOS and degree of saturation for selected intersections are given in Table 5. The degree of saturation of all

intersections is greater than 1 that results in Level of service for each direction as 'F'. Therefore, improvement is required in geometry of these intersections.

Table 4: Volume Capacity Ratio Vs. LOS		
V/C	Delay (sec /veh)	LOS
0.3	0-10	A-Free Flow
0.5	>10-15	B- Reasonably Free
0.8	>15-25	C-Stable Flow
0.9	>25-35	D-Approaching Unstable flow.
1	>35-50	E-Unstable Flow
>1	>50	F- Forced or Breakdown flow

Table 5: LOS and Degree of Saturation			
Sr. No.	Intersection Name		Prevailing Condition
1	Daska Intersection	LOS	F
		Degree of Saturation	3.17
2	Model Town Intersection	LOS	F
		Degree of Saturation	4.59
3	Gulistan Cinema Intersection	LOS	F
		Degree of Saturation	4.29

3.1 Daska Intersection

Degree of saturation of each direction of Daska intersection is given with respect to its level of service. Minimum and maximum degree of saturation is 2.19 and 5.24 respectively (Fig. 5). At Daska intersection modification is done by provided giveways, bus bay, parking area and specified one lane for slow moving vehicles as shown in Fig. 6. At Daska intersection fixed signals cannot be provided because traffic flow at this intersection is very high.

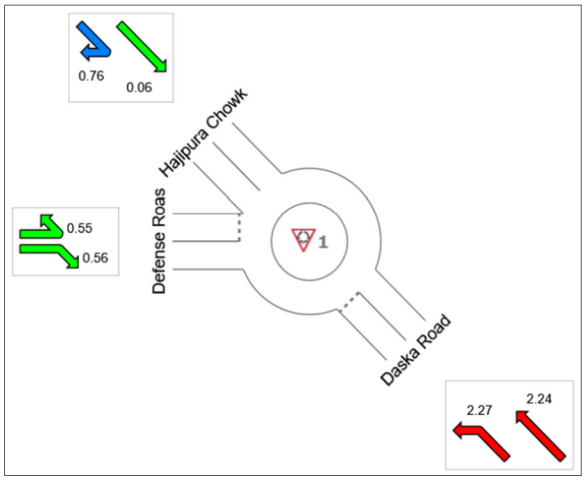

Fig. 5: Degree of Saturation of Existing Condition at Daska Intersection

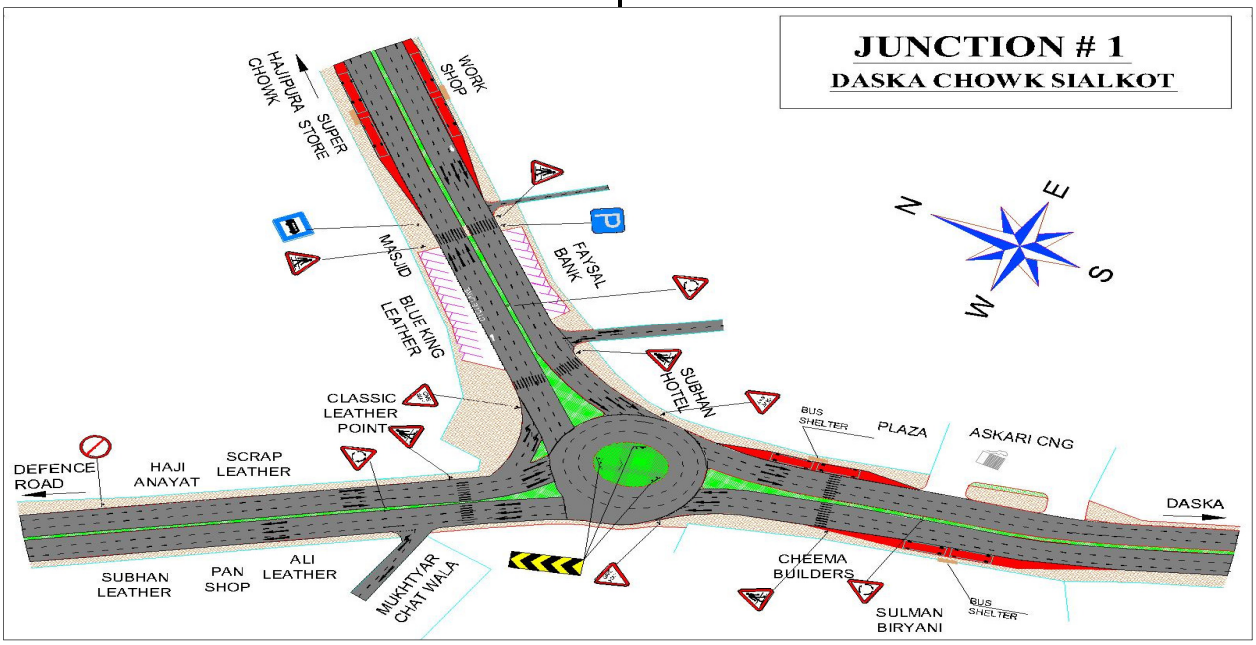

Fig. 6: Modified Condition of Daska Intersection

Analysis of Daska Intersection with modification resulted in improvement of LOS of three directions (Fig. 7). The LOS in the other two directions is not improved because of limitation of SIDRA software. SIDRA software is very useful software for the calculation of level of service and degree of saturation but at the same time it has some limitation such as no option for bus bay, parking and lane specification. It is understood that if parking area and bus bay are provided on this intersection, the traffic flow will be improved. Traffic conflicts mostly occur at that intersection due to stoppage of buses and cars on roads.

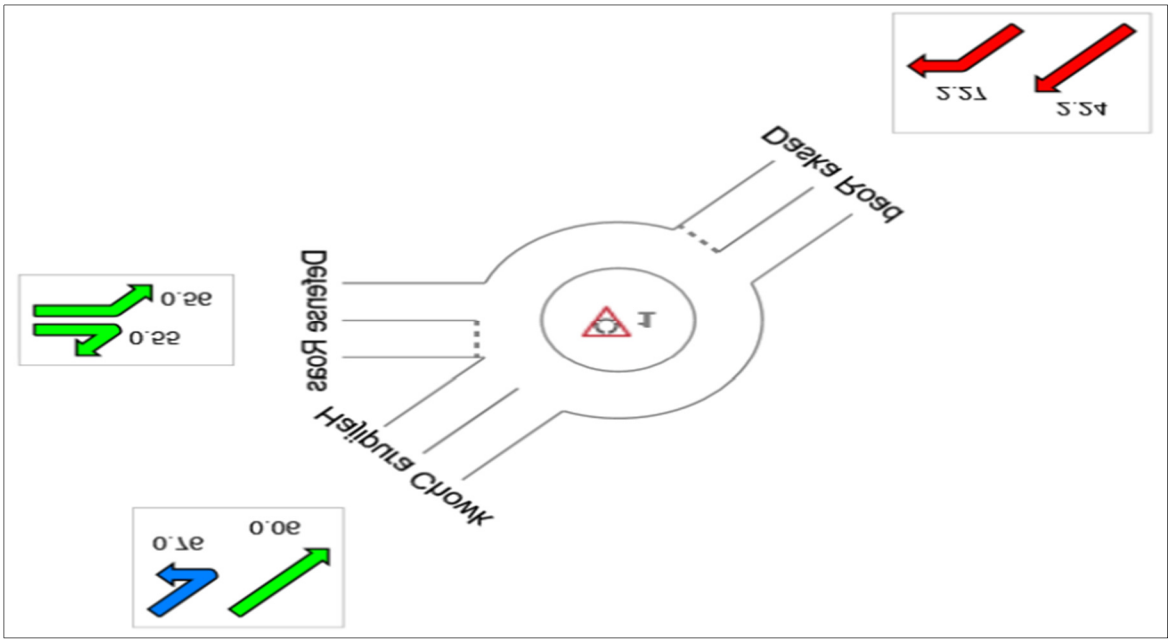

Fig. 7: Degree of Saturation in Modified Condition at Daska Intersection

3.2 Model Town Bhed Puli Intersection

Degree of saturation of each direction of Model Town intersection is given with respect to its level of service in Fig. 8. Minimum and maximum degree of saturation is 4.05 and 5.32 respectively. Level of service for each direction is 'F' that means there is need of improvement in geometry of this intersection. After analyzing the level of service of existing condition of Model Town intersection, the intersection is modified considering various aspects like geometrical design of the intersection and separates the slow moving traffic by provision of lane shown in Fig. 9.

Analysis of Model Town intersection with modification resulted in improvement of LOS of three directions (Fig. 10).

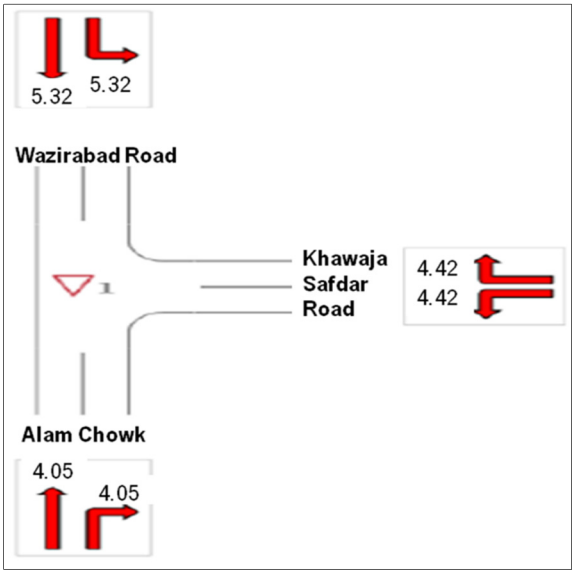

Fig. 8: Degree of Saturation in Existing Condition at Model Town Intersection

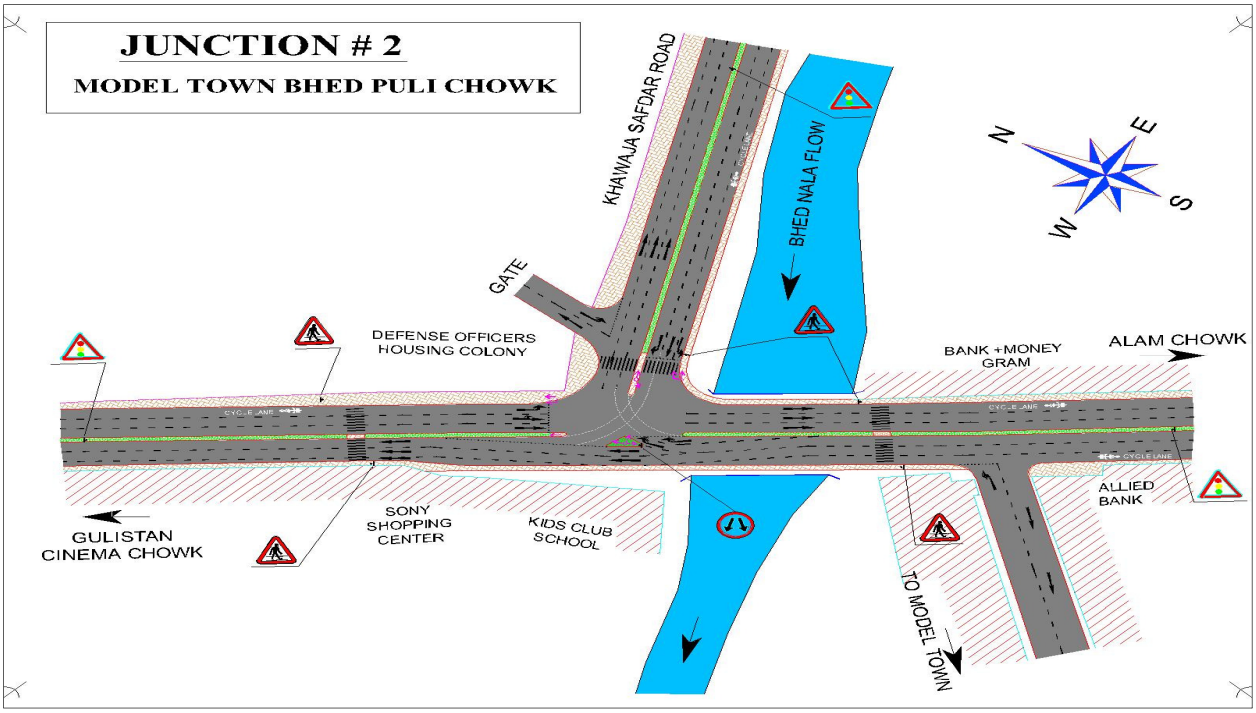

Fig. 9: Modified Design of Model Town Intersection

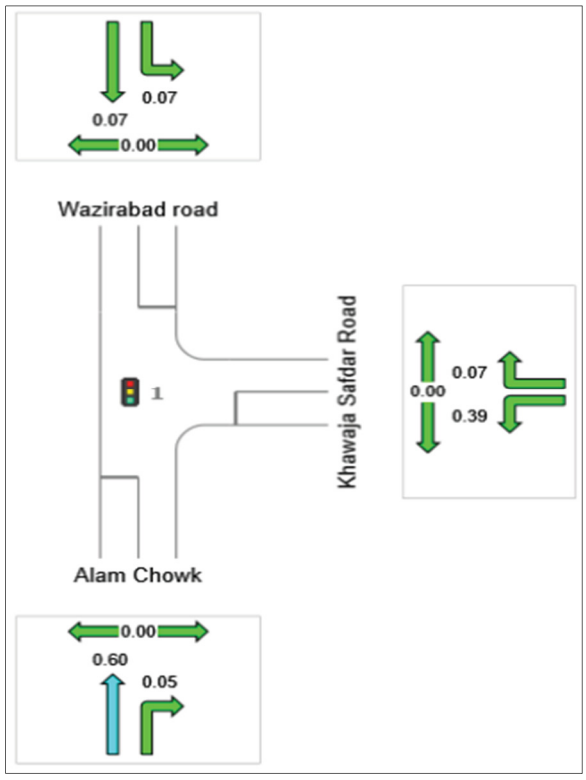

Fig. 10. Degree of Saturation in Modified Condition at Model Town Intersection

3.3 Gulistan Cinema Intersection

Degree of saturation of each direction of Gulistan Cinema intersection is given with respect to its level of service in Fig. 11. Minimum and maximum Degree of Saturation is 1.01 and 6.94 respectively. Level of service for each direction is 'F' that means there is need of improvement in geometry of this intersection. After analyzing the level of service of existing condition of Gulistan Cinema intersection, geometrical changes such as provision of slow moving lane are proposed as shown in Fig. 12.

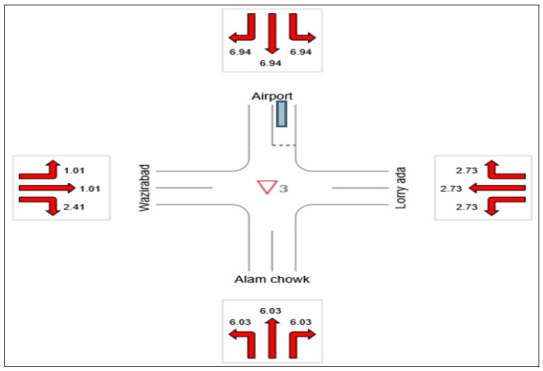

Fig. 11: Degree of Saturation in Existing Condition at Gulistan Cinema Intersection

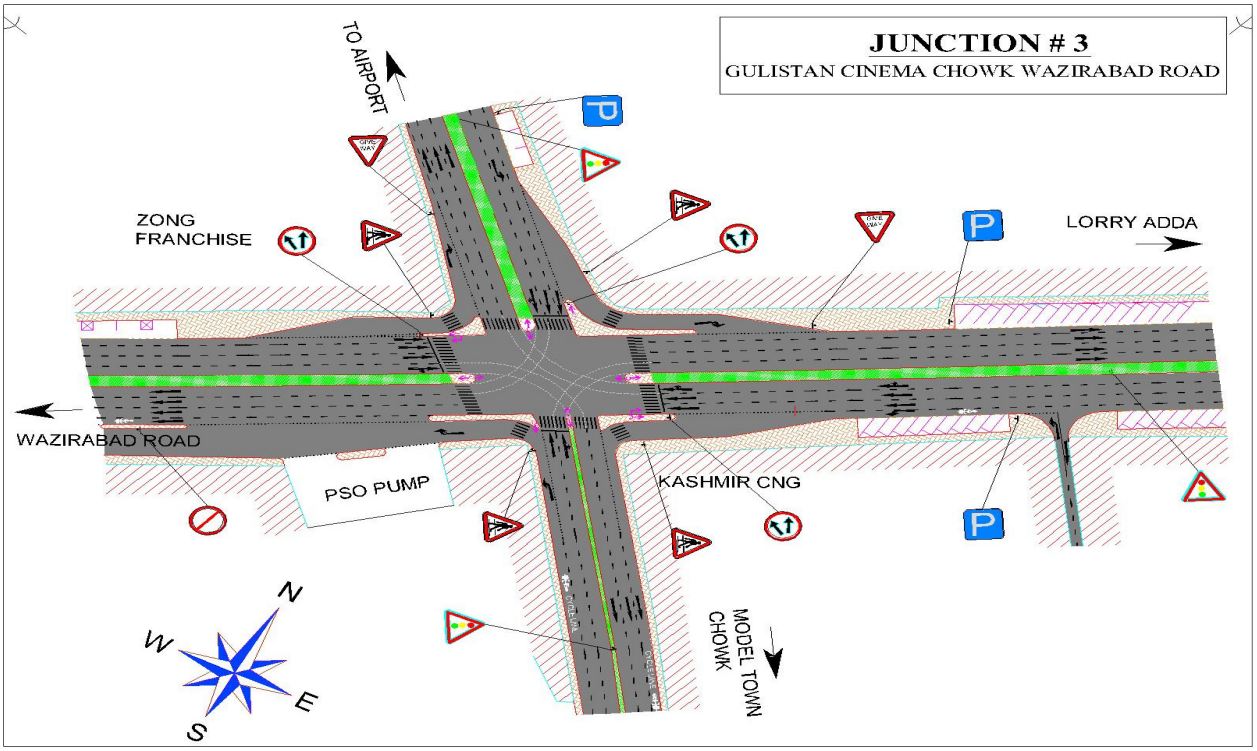

Fig. 12: Modified Design of Gulistan Cinema Intersection

Analysis of Gulistan Cinema intersection with modification resulted in improvement of LOS of four directions (Fig. 13). LOS of all the three intersections is improved from 'F' grade to 'A'. Comparison of LOS and degree of saturation for all the selected intersection is given below in Table 6.

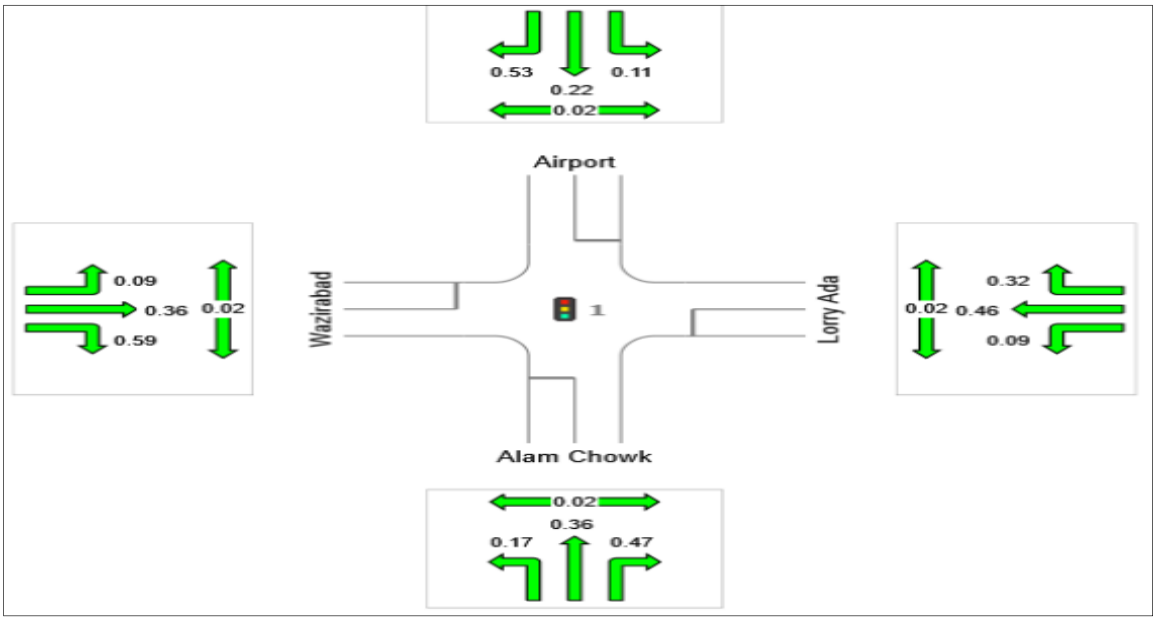

Fig. 13. Degree of Saturation in Modified Condition at Gulistan Cinema Intersection

Table 6: Comparison of LOS for All Three Intersections				
Sr. No.	Intersection Name		Prevailing Condition	Modified Condition
1	Daska Intersection	Level of Service (LOS)	F	Very near to A
		Degree of Saturation	3.17	1.06
2	Model Town Intersection	Level of Service (LOS)	F	A
		Degree of Saturation	4.59	0.21
3	Gulistan Cinema Intersection	Level of Service (LOS)	F	A
		Degree of Saturation	4.29	0.23

4. CONCLUSION

In this study, LOS of Daska, Model Town and Gulistan Cinema intersections in Sialkot are investigated. Following conclusion can be drawn from the study:

1. It was observed that traffic volume is higher at Daska Intersection as compared with other two intersections.
2. LOS of Daska intersection can be improved by provision of parking area, bus shelter, giveways, traffic signs and an additional lane in all direction. It can remain as an unsignalized intersection because extra space is available to make freeway. The parking bay is recommended to improve the LOS at the intersection, but in analysis, traffic going to Hajipura Chowk from the Daska road was not improved because of SIDRA's limitation regarding bus bay provision and parking area.
3. Traffic conflicts are lower for Model Town and Gulistan Cinema Intersection as compared with Daska Intersection.
4. LOS of Model Town and Gulistan Cinema Intersection can be improved by providing signalized intersection along with give ways, increasing lane width and one lane for slow moving vehicles. SIDRA analysis for proposed modification reveals good Level of service at these intersections.
5. The conflicts at Model Town and Gulistan Cinema Intersection can be further minimized by installation of fixed time signal.
6. The Level Of Service (LOS) for Daska, Model Town and Gulistan intersection can be improved from 'F' to 'A' or 'B' grade with suggested modification.

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