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Traffic Analysis: Case Study (N-5 Corridor Rawalpindi, Pakistan)

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Abstract:

The objective of this study is to highlight difficulties that the road users face on a constant basis while traversing the corridor. These include the identification of measures to mitigate the current predicaments of congestion along the corridor which include less than favorable traffic progression, and an unacceptable level of delays along with the environmental ordeals translated by emissions and noise emanating from the Vehicles. The scope of the project is limited to the corridor from Golra intersection on N5 to GHQ intersection about 14 km further down the corridor amongst the heart of the city. On-field readings included manual counts performed by Jamar Counter, signal timing and link lengths determinations formed the basic inputs that were utilized by the analysis software SYNCHRO for outputs such as Level of Service (LOS), Intersection Capacity Utilization (ICU), travel delays at each intersection and Volume to capacity ratios. The analysis performed by the software was not limited to only existing/current scenarios but was broadened out to include future projected values for improved as well as unchanged scenarios. It also included values for oxides of carbon and NOx emissions in addition to queue lengths and fuel used that enabled a comparison to be illustrated figuring out the impacts on the environment. The improved scenarios drawn up

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included lane width expansions where possible to suggesting traffic management plans where the geometry and the proximity of the built-up area forced, no grade separation to be performed and the coordination of traffic signals that were in close vicinity such that coordination limitations were fulfilled. Grade separation was also envisaged on the Golra intersection as the geometry of the intersection was feasible for the construction of such structure. These plans, if implemented and led to fruition by the concerned authorities would provide road users with a general peace of mind associated with a smoother traffic flow, reduced emissions and minimal bottlenecks and a corridor convenient as well as economical to traverse.

Key words: Delays, Level of Service (LOS), Intersection capacity utilization (ICU), volume to capacity ratios, Phase length, Synchro P6, Environmental impact assessment, Queue length

1. Introduction

Motorization and its growing use has been a major factor leading to an increased mobility of people, goods and services with a consequent development and economic progress. While this phenomenon has brought irrefutable benefits, it has not been without deleterious effects. This has been primarily in terms of the loss of smooth traffic flow, increased pollutants emitted into the atmosphere from motor vehicle exhausts, congestion, haphazard urban development and land use, oil dependency, and other related problems. Pakistan has a burgeoning road transport network which shows no signs of cessation due to inefficiencies of the operational and planning procedures being employed by the Pakistan railways which are dismal to say the least. The future projections show an increasing trend for passenger traffic while a little improvement may be expected in the freight traffic column. This in turn poses the roads with the threat of being used well beyond what they were actually designed for. Our study area encompassing the segment of N5 national highway from Golra

intersection to GHQ intersection in Rawalpindi also faces these acute problems. This arterial serves not only the CBD of Rawalpindi city but also the freight hub of the city such as Ghalla Mandi. Consequently the corridor contains a diversity of vehicle types ranging from large trailers to motorists and motor bikes. Serving these diverse vehicle types can be a cumbersome process as they all must be catered and accounted for when planning for improvement of existing arterials and highways. Lack of studies conducted by the transport research department and unavailability of key data for the purpose of analysis makes it even harder for the concerned parties interested in proposing solutions and traffic management plans.

2. Methodology

The basic aim of our methodology was to focus on the determination of Level of Service (LOS) for the existing and projected conditions of the traffic on the intersections that were to be covered.

The procedure adapted by authors consists of the collection of traffic counts for the turning movements and through movements at our intersections. The traffic counts were measured using JAMAR counter. As this study was based on Vehicle classification so after the data collection, there was a need to convert this data into passenger car units to bring the data into one form i.e. Passenger Car Equivalents and use it as an input for volumes in Synchro. The Values used for Passenger Car Equivalents are shown in the table below:

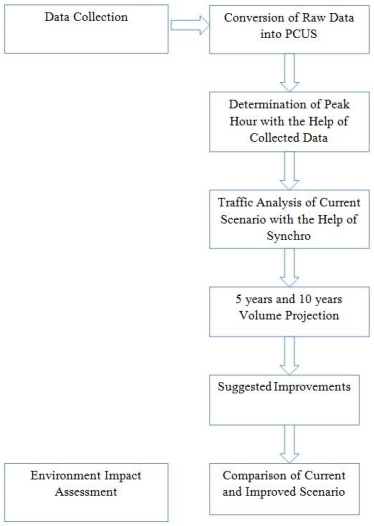
Vehicle Type	Passengers Cars Equivalent factor
Bike	0.4
Motor Car	1
Van/Pickup	1.5
Bus	2
Heavy	2.3

Subsequently from this data, the peak hour volumes and peak hour factor was determined for every individual intersection. This peak hour volume and peak hour factor was further used along with the existing cycle length and existing green time to determine the existing overall delay, capacity of each movement and for whole signal along with LOS and ICU with the help of software SYNCHRO.

After the analysis was done using the current volumes, the volumes were then projected for 5 & 10 years using the rate of growth as 3.5 % and the intersections were then analyzed again. After the completion of current analysis the improvements were suggested for every intersection and then were analyzed again for current volumes and 5 and10 years projected volumes, subsequently the comparison was made between the current scenarios and suggested improvements.

After the Traffic Analysis, Environment Impact Analysis was also performed in order to determine the effect on environment due to delays occurring on the corridor. Fuel Consumption and Emission of gases are calculated and a comparison is to be done on the current and improved scenario.

The Flow Chart of the Study



3. Analysis and Results

The results of our intersection analysis have been represented in this unit, it includes existing and after improvement results. Synchro software was used to analyze the data and to obtain these results. Outputs from the software include intersection delays, Intersection Capacity Utilization, Volume to capacity ratios, emissions, LOS and ICU for current and upcoming years.

Golra Intersection

Golra intersection is located on the N-5 highway forming the entry point of traffic from Islamabad and Peshawar as well as the motorways. It is a 4-legged signalized urban intersection consisting of major roads East Bound (EB) and West Bound (WB) and Minor road South Bound (SB) and Minor road north bound (NB). The WB section contains five through lanes with a right turn allowed movement, and one left turn lane. EB consists of 4 through lanes with one for left turn, and one for right turning vehicles. SB consists of two through lanes with allowed right and left turning movements. NB consists of two through lanes with allowed right and left turn. Each lane is 12 feet wide. The existing signal cycle length was 167 seconds after analyzing the intersection on Synchro 7.0 we found that intersection signal delay is 372 seconds, intersection capacity utilization (ICU) is 158% ,Maximum v/c ratio is 2.65 and intersection LOS was "F". In order to improve the traffic scenario at this intersection, the movements of SB and NB were directed to their respective left turn free lanes. And a U-turn is provided at EB and WB approaches in order to allow the conflicting movements. After the improvement of the urban signalized intersection, LOS changed from F to D, ICU decreased from 158% to 105.5% and the intersection delay is reduced from 371.4 seconds to 46.1 seconds.

Results Before Improvement		**Results After Improvement**	
Cycle Length (s)	167	Cycle Length (s)	120
Control Type	pre timed	Control Type	pre timed
Maximum v/c Ratio	2.65	Maximum v/c Ratio	1.16
Intersection Signal Delay (s)	371.4	Intersection Signal Delay (s)	46.1
Intersection Capacity Utilization (ICU)	158%	Intersection Capacity Utilization (ICU)	105.5%
Intersection LOS	F	Intersection LOS	D
ICU Level of Service	H	ICU Level of Service	G

Chairing Cross Intersection

Chairing cross intersection is located on N-5 highway. It is a 3-legged signalized urban intersection. It consists of major road East Bound (EB) and West Bound (WB) and Minor road South Bound (SB). WB consists of 4 through lanes with one allowed right turn, and one left turn lane. EB consists of 2 protected right turn lanes. SB consists of two right turns lanes and one left turn lane with storage length of 30 feet. The existing signal cycle length is 88 seconds. Existing actual green time for WB is 31.5 seconds. For EB green time is 22 seconds. For SB actual green is 17 seconds. Yellow times for all approaches are 5 seconds and all red time for all approaches is 0.5 seconds. To analyze the current traffic condition at Chairing cross intersection, the existing Parameters were entered in Synchro. Synchro, Intersection delays is 176 seconds, Intersection capacity utilization (ICU) is 85%, Maximum v/c ratio is 1.47 and signal level of service (LOS) is "F". In order to improve the traffic scenario at this intersection, the signal of this intersection and Honda Showroom (the Succeeding intersection on the corridor) intersection are coordinated. After the Improvement of the urban signalized intersection the LOS changed from F to E, ICU decreased from 85% to 81.4% and the intersection delay is reduced from 176.5 seconds to 61.5 seconds.

Results before improvement		**Results After Optimization**	
Cycle Length (s)	88	Cycle Length (s)	110

Control Type	Pre-timed	Control Type	Coordinated
Maximum v/c Ratio	1.47	Maximum v/c Ratio	1.07
Intersection Signal Delay (s)	176.5	Intersection Signal Delay (s)	61.5
Intersection Capacity Utilization (ICU)	85%	Intersection Capacity Utilization (ICU)	81.5%
Intersection LOS	F	Intersection LOS	E
ICU Level of Service	E	ICU Level of Service	D

Honda center Intersection

Honda Centre intersection is located on N-5 highway. It is a 3-legged signalized urban intersection. It consists of major road East Bound (EB) and West Bound (WB) and Minor road South Bound (SB). WB consists of 4 through lanes with one allowed left and right turn. EB consists of 2 exclusive right turn lanes. SB consists of two right turns lanes and one left turn lane with storage length of 25 feet. The existing signal cycle length is 87 seconds. Existing actual green time for WB is 44.5 seconds. For EB green time is 16 seconds. For SB actual green is 7 seconds. Yellow times for all approaches are 6 seconds and all red time for all approaches is 0.5 seconds. To analyze the current traffic condition at Honda Centre intersection, the existing parameters were entered in Synchro 7.0. Result under existing scenario is ; Intersection delay is 78 seconds, Intersection capacity utilization is 76.1%, Maximum v/c ratio is 2.02 and Intersection level of service (LOS) is "E". In order to improve the traffic scenario at this intersection, the signal of this intersection and chairing cross intersection (the Preceding intersection on the Corridor) were coordinated. After the improvement of the urban signalized intersection the LOS changed from E to D, ICU decreased from 76.1% to 73.8% and the intersection delay is reduced from 77.5 seconds to 41.8 seconds.

Results before improvement		**Results after improvement**	
Cycle Length (s)	87	Cycle Length (s)	90
Control Type	Pre-timed	Control Type	Coordinated
Maximum v/c Ratio	2.02	Maximum v/c Ratio	1.01
Intersection Signal Delay (s)	77.5	Intersection Signal Delay (s)	41.8
Intersection	76.1%	Intersection Capacity	73.8%

Capacity Utilization (ICU)		Utilization (ICU)	
Intersection LOS	E	Intersection LOS	D
ICU Level of Service	D	ICU Level of Service	D

GPO Intersection

GPO intersection is located on Mall road Rawalpindi. It is a 4-legged signalized urban intersection. It consists of major road (North West Bound (NWB) and South East Bound (SEB)) and Minor road (South West Bound (SWB) and Minor road North East bound (NEB)). NWB consists of five through lane with one left turn allowed movement, and one exclusive right turn lane. SEB consists of four through lanes with one allowed left turn, and one right turn lane. SWB consists of two through lanes with one allowed right, and one left turn lane with storage length of 15 feet. NEB of two through lanes with one allowed right, and one left turn lane with storage length of 12 feet. The existing signal cycle length is 148 seconds. Existing actual green time for NWB is 42.5 seconds. For SEB green time is 44.5 seconds. For SWB actual green is 21.5 seconds. For NEB green time is 21.5 seconds. Yellow times for all approaches are 4 seconds and all red time for all approaches is 0.5 seconds. To analyze the current traffic condition at GPO intersection, the existing parameters must be entered in Synchro. Synchroc, on the basis of these inputs, will show the existing traffic scenario at the GPO intersection, Intersection delay is 340 seconds, Intersection capacity utilization (ICU) is 150.3 %, Maximum v/c ratio is 2.13 and Intersection Level of service is "F". In order to improve the traffic scenario at this intersection, the through and right turn movements of minor roads and the right turns of major roads were blocked and diverted to their respective next intersections and improved results are; Intersection delays reduced to "zero" because GPO intersection become unsignalized, Intersection capacity utilization (ICU) is 97.5%, and Level of Service (LOS) is "U" as GPO intersection become unsignalized.

Results before Improvement		**Results After Improvement**	
Cycle Length (s)	148	Cycle Length (s)	NA
Control Type	Pre-timed	Control Type	unsignalized
Maximum v/c Ratio	2.13	Maximum v/c Ratio	NA
Intersection Signal Delay (s)	340	Intersection Signal Delay (s)	NA
Intersection Capacity Utilization (ICU)	150.3%	Intersection Capacity Utilization (ICU)	97.7%
Intersection LOS	F	Intersection LOS	U
ICU Level of Service	H	ICU Level of Service	F

GHQ Intersection

GHQ intersection is located on Mall Road Rawalpindi. It is a 3-legged signalized urban intersection. It consists of major road (South East Bound (SEB) and North West Bound (NWB)) and Minor road South West Bound (SWB).SEB consists of one U-turn lane, 4 through lanes, and one allowed left turn lane with storage lane length of 50 feet. NWB consists of one right turn lane with allowed U-turn movement, and four through movement lanes with allowed right turn movement lane. SWB consists of two right turns lanes and one left turn lane. The existing signal cycle length is 100 seconds. Existing actual green time for SEB is 37.5 seconds. For NWB green time is 31.5 seconds. For SWB actual green is 17.5 seconds. Yellow times for all approaches are 4 seconds and all red time for all approaches is 0.5 seconds.

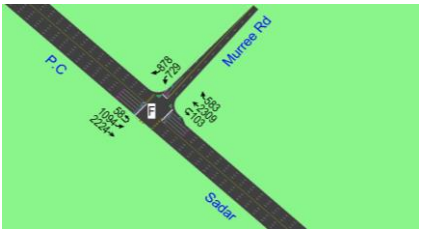
To analyze the current traffic condition at GHQ intersection, the existing parameters were entered in Synchro. The results obtained are; Intersection delay 348 seconds, Intersection capacity utilization (ICU) is 150%, Maximum v/c ratio is 2.42 and Intersection level of service (LOS) is "F". In order to improve the traffic scenario at this intersection, the through volume coming from SEB towards NEB is made signal free by providing an additional lane. It was decided to add another lane after a site visit as there is space available. The additional volume from GPO intersection was added to these intersections SEB U-turn. After the improvement the urban signalized intersection's LOS remained F, ICU increased from

150% to 154.4%, the intersection delay is reduced from 348 seconds to 256.8 seconds.

Results Before Improvement		**Results after Improvement**	
Cycle Length (s)	100	Cycle Length (s)	150
Control Type	pre timed	Control Type	Pre timed
Maximum v/c Ratio	2.42	Maximum v/c Ratio	1.93
Intersection Signal Delay (s)	348	Intersection Signal Delay (s)	256.8
Intersection Capacity Utilization (ICU)	150%	Intersection Capacity Utilization (ICU)	154.4%
Intersection LOS	F	Intersection LOS	F
ICU Level of Service	H	ICU Level of Service	H

4. Discussion

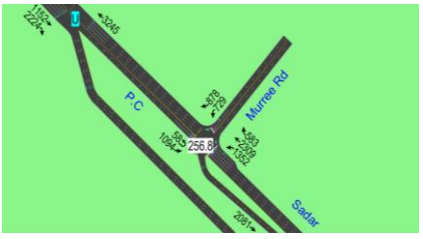
In this section the figures of improved and existing scenarios are presented for GHQ intersection. The figures address the following characteristics of the intersection; Level of Service (LOS), Intersection capacity utilization (ICU), volume to capacity ratio, Intersection delays.



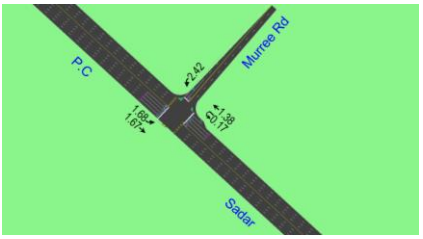
a)Level of Service and Volume Counts before improvement

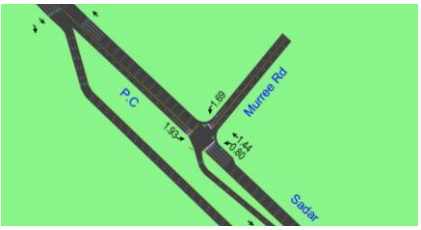
b) Level of Service and Volume Counts after improvement

c) Delays and Volume Counts before improvement



d) Delays and Volume Counts after improvement





e) Volume to Capacity before improvement

f) Volume to Capacity ratio after improvement

Conclusion

Conclusions enlisted below are based on the research findings.

1. The results of the analysis by synchro/simtraffic show that the current number of lanes is not sufficient at Golra, GPO and GHQ intersection.
2. Increasing number of lanes improves intersection capacity utilization and its level of service.
3. Signal coordination between Chairing cross and Honda center reduced delays of intersection but not the Level of Service.
4. Traffic Management plans has reduced the delays at GPO and Golra intersection but it's a short term solution.
5. The result shows the optimization by synchro/simtraffic reduces the control delays and increases the intersection capacity and reducing the v/c
6. The optimization of signalized intersection by synchro/simtraffic changes the level of services of some of the approaches at the intersections but it has no effect on the level of service of the complete intersections.

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