To Know the Short and Long Term Improvement Works Required for the Bannu D.I. Khan Road

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***Abstract*— Bannu is one of the most important districts of Province Khyber Pakhtunkhwa on the basis of its geographical location and strategic values. It serves as a gateway to the neighboring country Afghanistan and hence to the Russian federation and other linked countries. With the passage of time it has shown substantial economic, social, and industrial growth. As it works as a trade centre between the established areas & federally administrated tribal areas of Pakistan, and Afghanistan so its roads gets very congested. The main D.I Khan Road which connects it to the important and main trade zones of the country was reconstructed in 2003, and now the fast economic development, increase in population, and change in land use patterns has made it heavily congested. The length of road under observation has been divided into residential, commercial, and industrial areas according to its surrounding. From 2003 to 2011, the number of vehicles has increased by 51%, so the level of service it provides in all the three zones lies in category "F" of the HCM. As Pakistan is a developing country and its authorities don't have enough funds to provide congestion free "A" level services, so this research was conducted to know short term policies to cope the problem, and according to results the level of service can be improved somehow by removing the encroachment and on-street parking specially in the residential area. But on the basis of existing situation, and keeping in view the building up peace in Afghanistan and the rapidly developing infrastructure in the tribal areas, the road passing through commercial and industrial areas would require extra widening.**

***Keywords*—** Bannu, Bannu Dikhan Road, Short Term and Long Term Improvement Works for Bannu D.I. Khan Road

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I. INTRODUCTION

Transportation is an essential part of every society. It has a strong impact on the lifestyle, the level and location of activities being involved, and the availability of goods and services for use. Transportation plays a key role in the development of a country; it contributes to the economy by production, distribution, and consumption of goods and services having impact on the place, time, quality and utility of goods and services. It also serves to the social, cultural, political, agricultural, defense, and environmental growth of the country.

Pakistan is geographically very important and serves as a way of transportation between the various parts of the world. It has significant contribution to the world trade because of its ports and roads, as most of the trade between various countries takes place through here.

II. OBJECTIVES

1. To know the type, number, and speed of the vehicles using this road.
2. To know the density and flow rate of vehicles.
3. To find the level of service of the road.
4. To find the increase in the number of vehicles from 2003 to 2011.
5. To find out various methods to reduce traffic congestion.
6. To analyze the traffic volume data collected on the road.
7. To develop a systematic way to find the capacity of a Two-lane road having mixed traffic conditions.
8. To improve the level of service of the road.

III. METHODOLOGY

1. Gather important data and information from the previous research & studies conducted.
2. Gather information from various departments and agencies regarding the land-use patterns, growth, economic and social development, transportation, and other important future factors.
3. Conduct the traffic volume survey, and collect other important data regarding the current infrastructure.
4. Evaluate the data to recognize various problems and their severity.
5. Keeping in mind the existing and future traffic, find the kind of improvements needed to cope this traffic.

IV. STUDY OF CONDITIONS

Bannu falls into the northern zone of Pakistan, having its borders with North Waziristan and hence Afghanistan, Lakki Marwat, and Karrak. The city is situated at 32.98 North and 70.60 East. This road serves as a transportation facility to this populated area, and international trade between Pakistan and Afghanistan & the central Asian countries. The landscape of the region is relatively flat. The typical weather is muggy tropical type and has dry and wet seasons. The starting of the wet season is when March ends and in October it finishes, while the dry season is usually pre dominant between November and February. The temperature is high in summer while low in winter, in summer it reaches up to 46^{o} C.

V. SELECTED ROAD FOR THIS STUDY

The area under study is the Bannu and D.I Khan road which connects the Bannu to the various important areas and trade zones of Pakistan. It is a representative section and is passing through residential, commercial, and industrial areas. It is a One-Way four lane road and was reconstructed in 2003 as a railway track from the area was removed, and up till now it has served for approximately 9 years. It has sufficient population on either side and has a width of 3.5 m per lane and shoulders of 2 m on each side. The two roads are separated by a median of 1 m width.

VI. DATA ACQUIRED

Study and survey was conducted to gather the data about the road as road length, width of the carriageway, width of the footpath, total right of way, width covered and on-street parking, and encroached area. Data about the vehicles speed, density, hourly volume, and peak hour volume was obtained via the traffic volume count survey. While data about the footpath, lightening, and drainage conditions was also collected.

The data about the traffic volume, speed, density, and flow rate was collected and tabulated as follows.

A. Traffic Volume

There are a number of techniques and equipments used to calculate the number of vehicles passing a point, some of them are manual counting, portable count method, and permanent counts.

For this research the manual counting method is used because it is relatively inexpensive, as little equipment is required for it and is cheap except labor cast, also it requires less time for its completion. The challenges faced in this method include personnel accurate observation, recording of data, and the labors getting tired after several hours of work (Table 1 to Table 3).

B. Speed

Speed is always an essential part of transportation planning. The method used here is manual count method. According to this method first a specified length i.e., one mile is marked which is measured with the help of a measuring Tap, Theodolite, or a Total Station where the coordinates of the two points are found by GPS. After specifying and measuring the distance, time taken to travel this distance is noted, this is done by giving a tag to the driver at entrance and receiving it back at exit. After knowing the distance and time taken to travel it, the speed can be calculated as (Table 4):

$$SPEED = \frac{DISTANCE}{TIME}$$

C. Density

Density is defined as the number of vehicles per unit section, so it is determined by dividing the total number of vehicles between these two points by the distance (Table 5).

D. Flow Rate

It is defined as the number of vehicles passing the road per hour per lane, and here the Flow rate is 2026 vehicles/hour.

E. Data Analysis

Data is analyzed to determine the growth factor and level of service.

F. Growth Factor

The method used for data analysis to determine growth factor is Paasche's method (introduction to statistical theory by Sher Muhammad Chaudry) which was presented by German economist Herman Paasche's. It is a statistical measure of average change in a variable or group of variable with respect to time. So it can be said that the index number is a device used to measure the change in data with the passage of time (Table 6).

Monitor the data taken at the construction of the facility and taken at present put it in the mathematical relation below to determine the growth factor.

$$P = \frac{\sum P_1 \times Q_1}{\sum P_0 \times Q_1} \times 100$$

Where,
P1= Time in current year.
Q1=Number of vehicles in current year.
Po=Time in base year.
Qo = Number of vehicles in base year.

By using the index method we got the result of 151.0389 which means that if the number of vehicles in 2003 were 100, it is 151.0389 in 2011. It indicates that the number of vehicles has increased by 51% in 2011 by comparison with 2003.

G. Level of Service

Level of service is the qualitative measure of traffic and it represents how good the current traffic condition of a facility is shown Table 7.

H. Road capacity

The method to calculate the road link capacity is as shown in Table 8 to Table 11.

The absolute road link capacity is considered to be in the range of 1300 to 1500 PCU/hr/lane. A mean PCU of 1400/lane width of 3.5 m, and hence 400 PCU per hour per meter of the carriageway is taken. Now the road link capacity is calculated by multiplying the absolute capacity (PCU of 400/meter) with

the width of carriageway in use, which is calculated as the actual carriageway width is reduced due to various factors affecting the capacity.

Using the above tables for reduction due to land use, parking, and encroachment, the effective carriageway width is calculated. On the basis of this carriageway width, and absolute capacity, the capacity of road link is calculated.

Carriageway Effective width = carriageway Actual width x (1-landuse/ 100)) - Parking space - *Encroachment*

Road link capacity = carriageway effective width x 400 passenger car units.

Comparing current traffic volume and the road link capacity, the ratio of volume and capacity is achieved which indicates the LOS and degree of congestion of a road link.

These factors which affect the road link capacity includes encroachment, parking, and land use, and resulting reduction caused by them is as follows:

For the designing of urban streets, Level of Service "C" is considered suitable (Kadiyali L.R 2007). Congested roads are those which have volume capacity ratio greater than 0.79

VII. KNOWING THE IMPROVEMENT REQUIRED TO COPE THE TRAFFIC

If the volume capacity ratio for a road is above 0.79, it means that the road is congested enough to carry this traffic and has to be improved. Following is the procedure adopted to know the type of improvement required.

Road links with volume capacity ratio greater than 0.79 requires improvement to carry the traffic, but instead of directly going for providing the extra-widening, first we remove the on street parking and encroachment. After the removal of these two factors the volume capacity ratio is again calculated, if it is below 0.79, then this road segment needs only the on street parking and encroachment to be removed.

Now if the volume to capacity ratio after the elimination of on street parking and encroachment is still greater than 0.79, extra widening has to be provided according to the right of way and available space.

If space is available in right of way then extend the carriageway to it width leaving space for pedestrians, and again calculate the volume to capacity ratio, if it is still greater than 0.79 then the road requires extra widening along with traffic management measures.

VIII. CONCLUSION

At the completion of this research, following recommendations are made for the improvement of this road in terms to carry the traffic.

1. Traffic rules and regulations should be strictly followed and implemented.
2. The level of service of road in all the three zones (residential, commercial, and industrial) falls in level "F".
3. The level of service can be improved from "F" level through the short term and long term methods.
4. The road through the residential area can be improved by short term method i.e. by the removal of on street parking and encroachment as it is simple, easy, and economical. Its volume capacity ratio after the removal of these two factors is 0.72 and falls to level "C".
5. The volume capacity ratio for industrial and commercial zones are 0.8 and 0.98, and falls into level "D" and "E" accordingly, hence keeping in mind the future requirements and traffic growth due to the up building infrastructure and peace in tribal areas and Afghanistan, here the method of improvement recommended is the long term method. Hence extra widening of the carriageway should be provided.

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TABLE1
HOURLY TRAFFIC VOLUME

S.NO	TIME	VEHICLES	TOTAL
1	8:10AM__9:10AM	All Types	1736
2	9:10 AM__10:10AM	All Types	1845
3	10:10AM__11:10AM	All Types	1413
4	11:10AM__12:10PM	All Types	1586
5	2:10PM__3:10PM	All Types	1080
6	3:10PM __4:10PM	All Types	1151

The peak hour volume for 24th November is 1845(9:10AM-10:10AM).

TABLE2
HOURLY TRAFFIC VOLUME

S.NO	TIME	VEHICLES	TOTAL
1	8:10AM__9:10AM	All Types	1253
2	9:10 AM__10:10AM	All Types	1029
3	10:10AM__11:10AM	All Types	1034
4	11:10AM__12:10PM	All Types	1095
5	2:10PM__3:10PM	All Types	1281
6	3:10PM __4:10PM	All Types	1289

The peak hour volume for 25th November is 1289(03:10 PM - 04:10 PM).

TABLE3
HOURLY TRAFFIC VOLUME

S.NO	TIME	VEHICLES	TOTAL
1	8:10AM__9:10AM	All Types	2004
2	9:10 AM__10:10AM	All Types	2026
3	10:10AM__11:10AM	All Types	1805
4	11:10AM__12:10PM	All Types	1640
5	2:10PM__3:10PM	All Types	1173
6	3:10PM __4:10PM	All Types	1357

The peak hour volume for 26th November is 2026(09:10 AM - 10:10 AM).

TABLE4
SPEED OF DIFFERENT VEHICLES

S. No	Type of vehicles.	Time (hour)	Length (mile)	Speed (mile/hour)	Avg speed (mile/hour)
1	Truck	0.0786	1.217	15.4834	17.4627
2	Rickshaw	0.0833	1.217	14.6098	
3	Dotson	0.0666	1.217	18.2732	
4	Motor	0.0541	1.217	22.4953	
5	Suzuki	0.0675	1.217	18.0296	
6	Cycle	0.0958	1.217	12.7035	
7	Motor cycle	0.0458	1.217	26.5720	
8	Horse cart	0.1055	1.217	11.5355	

TABLE5
DENSITY OF DIFFERENT VEHICLES

S. No	Type of vehicles.	Length (mile)	Number of vehicles.	Density. (Vehicles/ mile).
1	Truck	1.217	249	205
2	Rickshaw	1.217	201	166
3	Dotson	1.217	190	157
4	Suzuki	1.217	281	232
5	Motor cycle	1.217	145	119
6	Horse cart	1.217	226	187

TABLE 6
COMPARISON OF BASE YEAR AND CURRENT YEAR

Description Of Vehicle	BASE YEAR 2003		CURRENT YEAR 2011		P1Q1	P0Q1
	P0 = T0	Q0 = Tr0	P1 = T1	Q1 = Tr1		
Buses/Trucks	30	974	42	3793	159306	113790
10 Wheeler Trucks	36	619	48	2379	114192	85644
Tractors	24	62	27	266	7182	6384
Tractors With Trolley	24	307	26	1299	33774	31176
Dotson / Motor Cars	42	6652	66	32521	2146386	1365882
Animal Wheel Trolley	18	512	24	11400	273600	205200
Scooter Rickshaw	33	854	48	47893	2298864	1580469
Scooter / Motorcycle	45	202	69	82052	5661588	3692340
TOTAL					10694892	7080885

TABLE 7
LOS BY HCM

LOS	DESCRIPTION.	SPEED (Mi/h).	FLOW (Vehicle/hr/lane).	DENSITY (Vehicle/Mi).
A	Traffic moves at or greater than the mentioned speed. Motorists can easily switch between the lanes.	Above 59.99	Below 699	Below 11.99
B	A bit crowded, with some encroachment of maneuverability, lane change is limited and motorists may have to move side by side.	56.99 to 59.99	699 to 1099	11.99 to 19.99
C	Being able to change the lane is not sure. Experienced drivers may have comfort and mentioned speed can be achieved but the traffic on roads is near its capability. This level of service is desired for most urban highways.	53.99 t o 56.99	1099 To 1549	19.99 to 29.99
D	It is like urban highway during commute hours. Speeds are slightly decreased, motorists	45.99 to 53.99	1549 to 1849	29.99 to 41.99

	are edged in by vehicles			
E	Traffic flow becomes irregular and change in speed is abrupt, but the mentioned speed is achieved rarely. On highway this is uniform with a road above capacity it is designed for.	29.99 to 45.99	1849 to 1999	41.99 to 66.99
F	Flow is made to be inconsistent; speed varies frequently even approaching zero Mi/hr. Travel time cannot be predicted.	Below 29.99	Not stable	66.99 to maximum
F	Flow is made to be inconsistent; speed varies frequently even approaching zero Mi/hr.	Below 29.99	>1999 that is not stable?	>66.99

TABLE 8
PCU OF DIFFERENT VEHICLES

Vehicles	PCU
Bus, lorry/truck.	3
Car/Van.	1
Two wheeler.	0.5
Auto rickshaw.	0.6
Cycle.	0.4
Cycle rickshaw.	1.5
HD cart.	4.5
BD cart.	8

TABLE 9
REDUCTION CAUSED BY ENCROACHMENT AND PARKING

Reduction caused by encroachment and parking	
Encroachment severity and parking type.	Reduction (m)
Parking allowed on single side	2-3
Parking allowed on both side.	4-6
Marginal encroaching	1
Substantial encroaching	2
No encroaching	0

TABLE 10
REDUCTION CAUSED BY LAND USE

Reduction caused by land use in capacity	
Predominantly used land	Reduction (%)
Open space	0
for residential purpose	4-6
For institutional purpose	8-11
For industrial purpose	14-16
For commercial purpose	29-32

TABLE 11
VOLUME CAPACITY RATIO AND LOS

LOS adopted in the study.	
Volume capacity ratio	Level of service.
< 0.59	A
0.59-0.69	B
0.69-0.79	C
0.79-0.89	D
0.89-0.99	E
0.99 <	F