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Economic Evaluation of Proposed Bypass on SH-59 Passing through Bayad City

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Abstract- It is well known that with the rapid urbanization, vehicular traffic load on transportation system is also increasing day by day. This increase ill effect on the transportation system of urban area. It mainly causes traffic jam, excess delays etc. Bayad city of Aravalli district is one of the rapidly emerging urban areas of Gujarat state and it is also facing the transportation system problems on large scale. State Highway number 59 (SH 59), which is moving from Shamlaji to Vadodara, passes through CBD area of Bayad city. This highway carries most of heavy traffic from northern part of country towards Vadodara, Surat, and Mumbai side and vice versa. Hence, the economical option for present condition is to provide bypass for SH 59 from Vatrak to Madhavkampa. The present study is mainly intended for provision of bypass on SH 59. The possible traffic is calculated based on road side interview method. The economic evaluation of proposed bypass is carried out. It is concluded from economic evaluation that the total travel saving in 1 year due to construction of bypass is 5.9 crore and the benefit / cost ratio is 2.75, which indicates that the proposed bypass is economically feasible.

Index Terms - Bypass road, Economic Evaluation, Fuel Saving, Travel Time Saving.

1. INTRODUCTION

Due to rapid urbanization and fluctuation of vehicle population in the city, it is not possible to stop traffic and it is very difficult to provide extra land as per traffic demand. In the city, traffic jam problem may cause delay time and fuel consumption due to frequently stoppage of vehicles and the rate of accident will be increased. Due to fast growing vehicular traffic, cities become congested therefore, it requires effective controls to regulate the traffic and optimize delay and congestion of the traffic. The problem can be eliminated by providing bypass at out of the city. The bypass construction need very massive amount of investment and it also effect the economy of the country so before construction, it is required to check feasibility of the bypass construction. The present research work focuses on economic evaluation of bypass at Bayad city in Aravalli district of Gujarat state in terms of reduction in traffic as well as economic benefits. In this research work, various types of surveys are carry out like delay survey, spot speed survey, accident data collection, classified volume count survey and origin destination survey. Bayad city of Aravalli district is one of the rapidly emerging urban areas of Gujarat state and it is also facing the transportation system problems on large scale. State highway number 59 (SH 59), which is passing from Shamlaji to Vadodara. CBD area of Bayad city is situated along the state highway 59. Given state highway carries most of heavy traffic from northern part of country towards Vadodara, Surat, and Mumbai side and vice versa. The cities on these routes are highly congested and the accident rates are also high.

2. LITERATURE REVIEW

[A.V. ARJUN, 2013] **(1)** studied the economic feasibility of a flyover in Visakhapatnam (INDIA) between Maddilapalem and Satyam junction. Based on benefits and cost analysis, feasibility study had carried out. Sensitivity analysis carried out for taking into consideration 3 possibilities. From the sensitivity analysis, the IRR for the actual benefits and cost is 14.8%. Cost is increased by 15% and IRR is 13.9%. Benefits are decreased by 15% and IRR is 13.8%. Cost is increased and benefits are decreased simultaneously then the IRR is 12.9%, from this result construction of 4-lane flyover is feasible. [**ABEGAONKAR AMIT ANANTRAO, 2016] (2),** studied the traffic problem on straight bridge near IIT Guwahati campus because of continuous increasing in the campus population resulting in utilization of bus system, reducing comfort level of passengers. After a survey of the cost benefits analysis of ferry system show a high internal rate of return. The internal rate of return for a horizon of 20 years is determined to be 15.4 %, which makes it economically feasible to initiate the project. [**TODD LITMAN, 2016] (3),** studied on the application of economic analysis techniques in transportation planning and management. And describes specific techniques including cost-effectiveness, benefit-cost analysis, lifecycle cost analysis, and multiple accounts analysis. And conclude that economic evaluation is an important component of transportation decision-making and it can help identify the value of a policy or

program. [**ROLANDAS VITKŪNAS, 2011] (4),** studied on evaluation of bypass influence on reducing air pollution in Vilnius city. This paper addresses problem of increasing in vehicle that increasing traffic jams, which effect on pollution of the environment. The average speed on a bypass should be 1.57 times higher than taking the direct route in order to avoid the loss of travel time. Vehicles running on any kind of fuel, emit up to 35% less of carbon monoxide when driving at 40 km/h. [**RABA JAYESHKUMAR V. , 2016] (5),** studied on the traffic problem at the Bopal junction. Paper shows at Bopal junction along S.P. Ring road traffic delay and numbers of accident occurs due to trucks. And conduct such surveys on this junction like, classified volume count, accident data collection, delay survey etc. They conclude that to solve the traffic problems at Bopal intersection construction of a fly-over bridge will appropriate so delay and accident will be reduced and continuous movement along S. P. Ring road will be achieved. [**BANSARI N. DAVE, 2016] (6),** studied on the traffic jam problem due to railway crossing, which was situated on Rajkot - Morbi Road, about 1 km from Octroi Naka, which, results in a heavy traffic jam. They concluded that, the road carries more than 10,000 PCU daily. The proposed fly over is the perfect solution to overcome the traffic conflicts. [**NAYAN K. RABADIYA, 2015] (7),** studied on problem of large part of traffic movement in Nakhatrana in Kutch Local traffic cause un-necessary slow movement of traffic in which increase in vehicle operating cost and number of accidents. B/C Ratio for bypass road 1.34, which is greater than one so project is economically justified. The NPV for Bypass road is 186.84 lac which are positive and IRR value for Bypass road is 15%.

3. STUDY AREA

Bayad is situated in Aravalli district in Gujarat. It is one among the 6 blocks of Aravalli district. The height of Bayad is 106 m above sea level. Bayad is a Taluka in Aravalli district of Gujarat State, India. It is located 70km from State capital Gandhinagar towards west and 33 km from Aravalli district capital Modasa. Location of selected stretch is shown in fig. 1. The Bayad town has population of 17,886 of which 9,357 are males while 8,529 are females as per report released by Census India 2011. Total population of Bayad Taluka is 186,328 living in 36,256 Houses, Spread across total 289 villages, Males are 96,451 and Females are 89,877. Total area of Bayad Taluka is 590 km² including 559.24 km² rural area and 31.15 km² urban area. High congestion and delay are observed on the stretch passing through CBD area of city, as shown in the figure 1 with green line.

Figure 1: Map of Bayad city

4. DATA COLLECTION AND ANALYSIS

The data like volume, speed, delay at the Bayad intersection is carried out. The data for delay is collected on the week day (Monday and Friday) 21th January 2019 and 25th January 2019 between 9:30 AM – 11:30 AM at all the three leg of Bayad intersection considering different classification of vehicle by using manual method. The data for traffic volume is collected on the week day for the duration of 24 hours session by using conventional technique of pen and paper method.

4.1 *Road Inventory Data*

Road Inventory data are collected at various locations in Bayad city as shown in figure 2. The width of carriage way is 14.8m and at the entry and exit location, the width is 9.4m in the city. It is observed that the carriage way width in city is greater than compared to outer side location of the city.

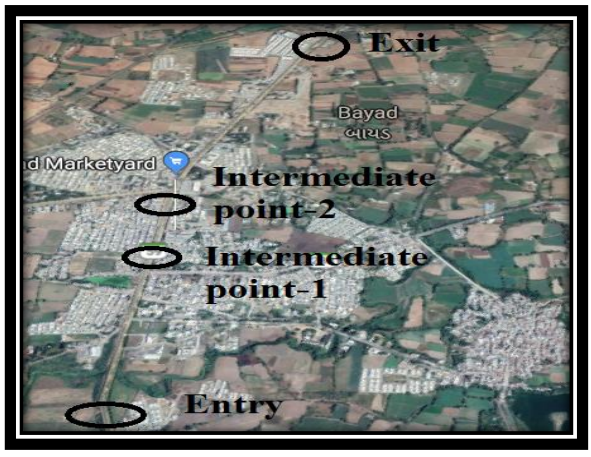

Figure 2: Locations of Inventory Data Collection

The detail of various items of road are described in the Table 1 below which include the item like shoulder width, length of carriageway, median width and total length etc.

Table: 1 Road Inventory Data

Description	Entry	Stretch (1)	Stretch (2)	Exit
Shoulder width	1.4 m	1.10 m	1.10 m	1.6 m
One-way lane width	6.1 m	7.95 m	7.95 m	6.22 m
Median width	0	1.10 m	1.10 m	0
Carriage way	9.4 m	14.8 m	14.8 m	9.4 m
Total length of road	12.2 m	17 m	17 m	12.4 m

4.2 Classified Volume Count

The objective of classified volume count survey is to find the traffic flow on the road. The hourly volume data 24 hours for the period of 15 min interval at intersection of Bayad city is analyzed and presented in table 2. Traffic Volume count is carried out by manual method on the selected approach of intersection and outside the city for 24 hours. It is observed that at 11am to 12 pm maximum traffic take place. The value obtained category wise and converted into PCU value as per IRC: 30:2009 **(8)**. The traffic vehicle composition observed at Bayad city which presented in the chart, which leads to the information related to the traffic composition.

Table 2: Total vehicles in number and PCU for day

No.	Type	Total vehicle	In PCU
1	T/W	22,700	11,350
2	Auto	2,901	2,901
3	Car	7,779	7,779
4	LCV	637	955
5	Truck	5,125	15,375
6	MAV	87	391
7	Bus	218	654
8	Cycle	114	57
Total		**39,561**	**39,463**

As shown in the table 2, it shows the overall number of vehicles passing from SH 59 through the city which interact the city traffic and causing the problem of traffic congestion. The number of vehicles is converted in terms of PCU by referring the value from IRC: 30-2009 **(8)**.

Total number of vehicles at the intersection is shown in the figure 3 and 4, which are passing through city and causing interruption in the flow of city traffic

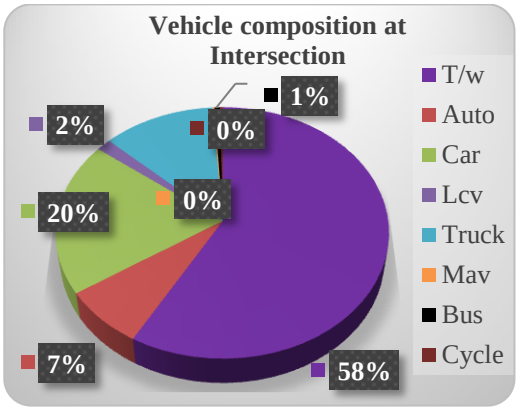

Figure 3: Vehicle Composition at Intersection

From the figure 3 it is clearly seen that in terms of number of vehicle composition of 2-wheeler are more at the city and the majority of traffic seen at the intersection is city traffic so it causes the complex situation when meet with the through traffic.

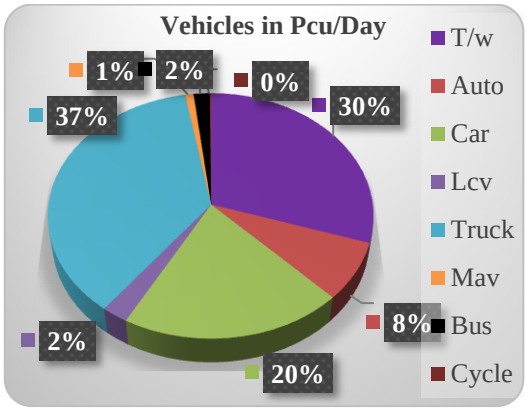

Figure 4: Total vehicle in terms of PCU/day

From figure 4, the observed composition of truck is 12%, but in PCU/day volume of truck is 37% means the mainly congestion problem in city caused by truck. So, it is observed that the proportion of truck and car in terms of PCU is very high compared to other modes of vehicle

4.3 *Delay Analysis*

The moving car observer method is a procedure commonly used to estimate the average flow and journey time of traffic on a road link through data collected from a moving vehicle. Delay performed for

2 days for each morning, afternoon and evening in working days.

Table 3: Observed operational delay

Observed Operational Delay (Second/vehicle)				
No	**Direction**	**Morning**	**Afternoon**	**Evening**
1	**Towards Modasa**	4.7	0.8	4.5
2	**Towards Kapadwanj**	4.0	0.8	4.2
Total in Minutes		8.9	1.6	8.7
Average		4.4	0.8	4.3
Average delay in seconds		266.1	50.5	261.7
Average delay Sec/veh		**192.8**		

In stream of traffic moving along a section of road considered 3.65 km for observation and fixed speed of test vehicle 30 Kmph. It is required to find out the delay on the selected stretch by measuring with the help of stopwatch, whenever the vehicle is travelling at the speed less than fixed speed considered. Survey conducted for 2 days in morning, evening peak period and afternoon to collect data. Travel time and delay are obtained from the analysis. The average journey speed, average running speed, average delay time are calculated from obtained data. The average delay per vehicle on selected stretch is 192.8 sec.

4.4 *Vehicle Occupancy*

The occupancy of various category of vehicle is observed during origin and destination survey. The occupancy of Bus, Car and Auto is 34.62, 3.67 and 3.7 respectively.

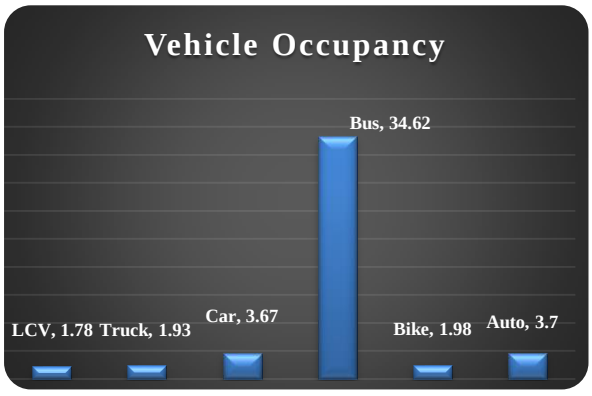

Figure 5: Occupancy of Vehicles

4.5 *Accident Data*

Accident data have been collected at Bayad police station. Maximum number of fatal Accident is 23.

Table 4: Accident Data

Sr. no.	Year	Major Accident	Minor accident	Fatal accident
1	2014	20	27	23
2	2015	12	27	16
3	2016	10	16	13
4	2017	9	30	10
5	2018	13	21	14

As per the guidelines of IRC SP: 30:2009 **(8)** the cost of Fatal, minor and major accident is found out shown in Table 5.

Table 5: Cost of Accident

Cost of Fatal	Cost of Major	Cost of Minor	Yearly cost
198.80	34.53	8.22	241.55
138.29	20.71	8.22	167.23
112.36	17.26	4.87	134.50
86.43	15.53	9.13	111.10
121	22.44	6.39	149.84
656.90	**110.49**	**36.84**	**804.24**

All values are in lacs

It is observed that saving in accident per year due to construction of bypass is Rs. 804.24 lacs.

4.6 *Origin-Destination Survey*

In the Bayad area, the road side interview survey is conducted to determine the amount of traffic that could potentially make use of bypass, if bypass facility is available Traffic for a bypass would consist of 'external local' and 'external through' traffic. In this method, drivers are stopped and interviewed at roadside and data recorded on prepared forms. Data about type of vehicle, Number of persons in vehicle, origin and destination of trip, purpose of trip, occupancy, time taken to pass the distance etc. are collected **(9)**.

Table 6: Response of road users for adopting proposed bypass

Vehicle	Responded Yes	Responded No
Truck	93%	7%
MAV	100%	0%
LCV	48%	52%
Car	81%	19%
Bike	22%	78%
Bus	10%	90%
Auto	20%	80%
Based on Opinion survey		

From Table 6, it is concluded that majority of vehicles like truck, MAV, LCV and car are expected to use the proposed bypass based on the willingness survey.

4.7 *Travel time saving calculation*

The proposed bypass will help vehicles to minimize the travel time. The calculation of travel time saving is determined based on the guidelines given in IRC: 30-2009 **(8)**. It is mentioned in Table 6.

Table: 7 Travel time saving

No	Type of Vehicle	Savings in vehicle time in Passenger-hours/day	Travel Time Saving in Rs./ Passenger – hour	Travel Time Saving in Rs. / day	Travel Time Saving in Lacs/ year
1	2w	529.56	67.48	35,735	**130.43**
2	3w	114.93	10.23	1,176	**4.29**
3	Car	1238.45	34.81	43,111	**157.04**
4	bus	82.57	10.23	845	**3.08**
5	LCV	29.17	10.23	298	**1.08**
6	Trucks	492.62	10.23	5,040	**18.39**
7	MAV	10.39	10.23	106	**0.38**
Total travel time saving cost					**3.15 Crore**

It is observed from Table 6 that if bypass is provided, Rs. 3.15 Crore will be saved per year in terms of travel time saving. Presently, it is cost to the road users passing through Bayad city.

4.8 *Fuel Consumption Saving*

To find out money saving, due to fuel consumption first of all vehicles benefitted by a bypass construction is to found out. Based on idle fuel consumption litre / hour and delay time saving, fuel consumption saving is calculated. Fuel saving is then divided with respect to vehicle fuel usage type and multiplied by respective fuel price (as on date 18/02/2019).

Table: 8 Vehicle get benefit by project

No.	Vehicle type	No. of Vehicles Benefitted by Construction of Bypass in 1 Day
1	Tw	4994
2	3w	580
3	Car	6301
4	LCV	306
5	Bus	48
6	Truck	4766
7	MAV	87

Based on classified volume count survey and origin destination survey the number of vehicles benefitted by construction of bypass for 1 day is shown in Table 7.

Table 9 : Fuel Rate

No.	Fuel	Rate
1	Petrol	69.21
2	Diesel	69.93
3	CNG	46.81
Price as on 18/2/2019		

Fuel rate is taken from the petrol pump of Bayad city. The rate of Petrol, Diesel and CNG is 69.21, 69.93 and 46.81 respectively as on date 18/02/2019.

Table: 10 Money Saving in Rs. per Year

Vehicle	Fuel saving during 1 day in liters	Saving in petrol (liter)	Saving in diesel (liter)	Saving in CNG (kg)	Money saving in lacs in 1 year
2w	90.94	90.94	0.00	0.00	22.97
3w	13.05	0.26	1.96	10.83	2.41
Car	182.22	71.07	52.85	58.31	41.40
LCV	1.77	0.02	1.69	0.07	0.44
Bus	14.09	0.14	13.39	0.56	3.54
Truck	219.51	0.20	208.54	8.78	55.28
MAV	4.01	0.00	4.01	0.00	1.02

It is observed that the maximum saving in fuel consumption due to construction of bypass is for truck and car.

4.9 *Total travel saving in Rs. in 1 year due to construction of bypass.*

By the summation of saving in travel time, saving in fuel consumption and saving in accident cost due to Construction of bypass the total travel saving is 5.91 Crore.

Table: 11 Travel saving in per 1 year due to Construction of bypass

No.	Saving	Total amount saving in one year in lacs
1	Travel time saving	315.03
2	Fuel consumption	127.09
3	Accident Data	149.84
Total		**591.97**
Cost in crore		**5.91**

According to planning commission, the discount rate considered for evalution of B/C and NPV are taken as 12 % **(8)**.

Table: 12 Result of Economic Evaluation

No	Benefit in lacs	Cost in lacs	Results
B/C	9056.40	3286.54	2.75 (ratio)
NPV	9056.40	3286.54	5769.85

From Table 11, it is concluded that proposed bypass is most feasible to provide for minimizing cost of accident, travel time, congestion etc.

5. CONCLUSION

If the bypass facility is provided, the saving in accidental cost, fuel consumption cost as well as delay cost in terms of passenger will be observed. Followings are the major conclusion of study.

1. If the bypass is constructed there will be total saving in travel time is **192.8 sec / veh**
2. The total saving per year with the construction of bypass will be **5.91 Crore**.
3. If the bypass is constructed there will be saving in accident cost is **149.84 lacs.**
4. It is observed by performing Economic evaluation by checking the bypass feasibility. The ratio of Benefit and Cost is **2.75** The Value of NPV is **5769.85 lacs.**

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