Kalpa Publications in Civil Engineering
Volume 1, 2017, Pages 7–15
ICRISET2017. International Conference on Research and Innovations in Science, Engineering &Technology. Selected papers in Civil Engineering

A Viability Study for Implementing Monorail as a Transit System for Urban Arterial Road: A Case Study of Ahmedabad.

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Abstract

The aim of this study is to investigate an novel mode of transportation from **Sarkhej Circle Ahmedabad to Pathika Gandhinagar** i.e. arterial road and how this system will be viable to four basic criteria: **Technically**, **Economically**, **safety** and **Ecofriendly**. This study gives modern concepts of a single rail serving as a track for passenger or freight vehicles, gives information about land use and public transportation planning, speed and movement. Monorail vehicles have benefited from modern transit technology.

The purpose of this Study is to investigate the viability of monorail as a new urban transit option along a corridor under study of section Sarkhej circle to Gandhinagar. The study is to determine that "Monorail" a fixed guideway technology known "Automated Guideway Transit" be a sustainable transport system which provide mobility and accessibility to all urban residents in a safe and environment friendly mode of transport. One alternative with the development of modern public transport system is monorail. A monorail as public transport very helpful for people in their daily activities also reduces the use of private vehicles and to reduce environmental pollution i.e. ecofriendly.

Keywords—Monorail; Traffic Congestion; Ecofriendly;

1 Introduction

1.1 GENERAL

The importance of transportation in the world development is multidimensional. It links residence with employment, good producer with the users. It also provides option for work, shopping, recreation, health, education, and other amenities. Urban Transportation infrastructure is looking up as transport demand in most Indian cities. It has increased due to increase in population as a result of migration from rural areas and smaller towns to cities. Transport in India has to be an integrated and diverse system with multiple modes of transport – buses, metro, monorail, private transport systems. Buses are not running in heterogeneous traffic with proper schedule. In

C.D. Modhera, G.J. Joshi, D. Soni, I.N. Patel, A.K. Verma, L.B. Zala, S.D. Dhiman, D.R. Bhatt, J.M. Rathod, B.C. Goradiya, M.S. Holia and D.K. Patel (eds.), ICRISET2017 (Kalpa Publications in Civil Engineering, vol. 1), pp. 7–15

maximum part of India there are no exclusive bus lanes.In urban transportation the problems that must be resolved as follows:

Congestion problem, Road user problem, eco problem, Deterioration problem, Disaster planning problem, Transportation efficiency improvement problem.Transportation where mobility is one of the objectives, transportation where traveling to the destination is itself the objective, transportation that is enjoyable, stress-free, and comfortable is perspective of transportation.

Under such condition the new and advance infrastructure called 'Monorail' can be introduce as solution of traffic and transportation problems**.** Monorail for transportation of people and light freight is characterized by the combination of the two words, "mono" (one) and "rail", meaning a transportation system that is supported and stabilized along a single rail, which commonly is called a beamway for an elevated system. **Monorail defined as** a single rail serving as a passenger or freight track for vehicles. The rail is elevated and can underground, on road.

1.2 NECESSITY OF MONORAILS

India is experiencing exceptional growth. India's population will be enormously 1.523 billion by 2030. Peoples of villages are moving from rural India to the cities. To cope up with this problem we need new cities develop in the next 20 years, the existing public transport infrastructure in our metropolitan cities are badly inadequate. Due to over population, car ownership and personal vehicles lead to traffic congestion. To deal with such problems of moving large numbers of people and vehicle monorail is a good solution. It is relatively cheap to construct, also ideal for transporting people from a city's suburbs to its commercial districts and vice a versa.

1.3 Aim & Objective of Study

The purpose of the Study is to introduce monorail transit system under study area between Sarkhej circle –Gandhinagar (Pathika) arterial Ahmedabad City. The study is to determine that "Monorail" a fixed guideway technology known "Automated Guideway Transit" in industry incorporated into a larger Alternatives Analysis of other high capacity transit options for section of Sarkhej to Gandhinagar.

The objectives are

- To conduct study on existing Mass Transportation System in the study area.
- To carry out viability study of Monorail Transportation System.
- To carry out Impact Assessment with respect to Environment, Congestion, Costing, Time and Space will be carried out.
- To carry out Economic Analysis of Monorail for the proposed route.

1.4 Scope of Study

The scope of study is between areas of Sarkhej circle to Gandhinagar.It includes:

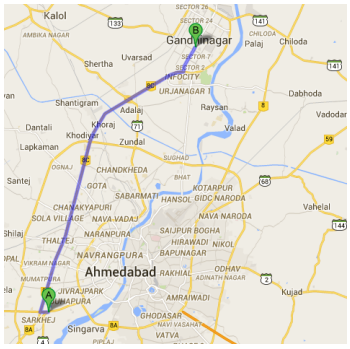
- Identification of preliminary priority corridors for urban transit.
- Analyze travel demand characteristics.
- To review & improve upon the existing design of corridor under study.
- To carry out Impact Assessment with respect to Environment, Congestion, Costing, Time and Space will be carried out.
- To carry out Economic Analysis of Monorail for the proposed route.

2. Literature review

Ashish verma(2010) In paper Challenges in Transportation Planning for Asian cities author wanted to give what are the transportation challenges in high density cities in Asia. Most of Asian cities are not having proper land use control, no proper roads and parking facilities, poor public transport and infrastructure which results in congestion, increased in accidents and most important increased in pollution. **John Pucher et.al (2004)** The author in his paper the Crisis of Public Transport in India: Overwhelming Needs but Limited Resources wants to pay attention on the difficulties rising due to over crowd in big cities in India. The author suggested various policies. If we remove some traffic from the streets reduce congestion to controllable levels and increase travel speeds. Public transport must be given priority attention to avoid air quality, traffic safety, congestion, and noise in Indian cities. Small increase in fares will yield considerable revenues for system maintenance, modernization, and expansion. Fares should be moderate so that middle-class riders cannot diverted to private transport modes, and it reduces the most urban transport problems. **Ashish Verma and S. L. Dhingra, (2005)** In the paper Optimal Urban Rail Transit Corridor Identification within Integrated Framework Using Geographical Information System discusses a model for optimally aligning an urban rail transit system within an integrated framework, on a demand- oriented corridor on a city transport network, using geographical information system GIS tools. It consists of two stages: public transport travel demand forecasting, and rail transit corridor identification using a GIS-based heuristic algorithm. **Naohito Matsui (2012)** The paper Strategic Urban Public Transport Improvements in Japan describes the latest situations in Japan's initiatives of low-carbon cities and development of public transportation (APMs, etc.) from the viewpoints of planning and technical theories. Global warming is one of the most important environmental issues. In order to encourage low-carbon city development, it is important to reduce CO2 and carbon sink increase in whole city. In this paper the author had given comparison of Intermediate Mass Rapid Transit Systems in Japan.

3. Study area

The Sarkhej circle –Gandhinagar Highway (32.2 km) which connects the city of Ahmedabad with Gandhinagar, is selected as study area. It has emerged as a hub for entertainment and corporations. The highway was primarily built as a mean of bypassing the city of Ahmedabad. But the cheap land prices lead to a boom of the retail industry. Presently, the prices of land in this area are more comparable to those in the proper city area. So the residential areas are increased in this section. Everyday people are travelling from Ahmedabad to Gandhinagar and vice a versa for employment.



4. Data collection

4.1 TRAFFIC STUDIES

With a view to estimate the base year traffic levels on the existing road system in terms of vehicle mix, traffic surveys were carried out to analyse the traffic characteristics. These studies help in deciding the geometric design features and traffic control for safe and efficient traffic movements.

Results of traffic studies, conducted occasionally and/or regularly by Govt. agencies have also been considered relevant for firming up traffic flows and the expected growth thereof. The feasibility of a transportation project and that too for a city like Ahmedabad having a huge population and a mix traffic condition always requires a long list of field (or primary) surveys to be conducted over a relatively large span of time, with a team of trained personal. Man power constraints, only the most relevant surveys were conducted and the details collected from the present surveys are compared with the available data and/or used for the dissertation.

The basic surveys carried out are namely:

- Road inventory survey,
- Willingness to pay and shift survey,
- Existing Public Transport Passengers (boarding – alighting) survey

4.1.1 Road Network inventory survey

Technical viability to implement Monorail treatment includes Road Width, Corridor/Road Length, number, and nature of bottlenecks. Road network inventory Survey has been carried out for entire length of corridor. In road inventory survey the information like carriage way width, Footpath width, Median Width, Junction inventory and Physical features like bus stops, trees, etc. was gathered.

Table 4.1 Road Inventory Survey
Corridor: Sarkhej circle to Pathika Gandhinagar

FROM	TO	Junction	J_Code	L(km)	R(m)	CW(m)
Sarkhej circle	Karnavati	Sarkhej circle	2	3.7	60	>21
Karnavati	Iskon	Karnavati	2	1.6	60	>21
Iskon	Pakwan	Iskon	Flyover	1.4	60	>15
Pakwan	Thaltej	Pakwan	1	0.5	60	>21
Thaltej	Ajanta	Thaltej	Underpass	1.4	60	>21
Ajanta	Highcourt	Ajanta	4	2.9	60	>15
Highcourt	Sola	Highcourt	4	1.1	60	>15
Sola	Gota	Sola	Flyover	1.4	60	>21
Gota	Nirma	Gota	2	4.2	60	>21
Nirma	Khodiyar	Nirma	3	3.3	60	>21
Khodiyar	Adalaj	Khodiyar	Flyover	1.2	90	>15
Adalaj	Uvarsad	Adalaj	3	1.2	90	>21
Uvarsad	Infocity	Uvarsad	2	6.0	90	>15
Infocity	Pathika	Infocity	3	2.3	90	>21

Observations:

- There is no BRT corridor in entire the route
- There is enough space available for Monorail route.

- The Monorail can be passed over the fly over of Iskon,Sola Gota , Adalaj, Narmada Canal Bridge and Railway Bridge by structural strengthening and proper structural design.
- There is enough median available for construction of Monorail line on the route.

4.1.2 Willingness to pay and shift survey

Survey had been carried out at 9 locations on the corridor. The survey locations were Sarkhej, Iskon, Thaltej, Highcourt, Sola Gota Adalaj, infocity Pathika and GH. The major observations from the survey are

- The GSRTC buses are not properly scheduled and are running with their over capacity on the study area.
- Travel time through area is very high due to signals, manually controlled intersections and repeated stopping of the vehicles.
- As per the records of survey, commuters are eager to adopt new mode of transportation which provides Comforts, Level of service, saving in travel time and Environment friendly.
- Commuters can use the various schemes like Student pass, Smart Cards, Senior citizen pass, Seasonal pass.

4.1.3 Public Transport Passengers (Boarding / alighting) survey

To ascertain the link loads on the existing transit corridor and establish the passenger transport demand, the bus passengers Boarding/Alighting survey is one of the survey to be conducted on corridor under study. Surveyors have to travel in the bus and note down the number of passengers boarding and alighting at each bus stop. But as and when during the study there were no bus- routes running on this full stretch of road. Only one bus, that too for only 1 km part was there.

The survey was carried out along the corridor, with the objectives to analyze the following:

- Major Activity centers along the corridor
- Major Transfer Points along the corridor
- Existing public transport usage along the corridor
- The survey was carried out from Sarkhej Circle to Pathika Gandhinagar and vice-a versa in GSRTC bus.

4.1.4 Volume at the Corridor

At both side of corridor there is a development of residential area and industries. Because of this, the traffic flow is very heavy in the mornings and in the evening, which causes serious traffic congestion and frequent traffic jams, accidents on the roads during morning and evening peak periods.

Table 4.2 Traffic Volume of section from Sarkhej circle to Gandhinagar At peak hour

Section	Types of vehicles			
	Car	2 W	3W	Bus
Sarkhej	628	512	400	85
	487	418	380	42
Pakwan	812	936	700	47
	789	873	636	48
Thaltej	1682	1173	541	51

	1766	972	262	57
Cambay	1632	1005	539	55
	1530	1088	563	54
Gota	1611	956	206	54
	1462	789	174	58
Vaishnodevi	1624	925	155	55
	1379	674	164	62
Infocity circle	1671	1039	255	115
	1526	1153	240	113

4.2 Conclusion:

- The route selected is having one of the highest mobility on daily basis. It also serves many regular work trips. The selected corridor is one of the most viable routes for the Monorail Transportation System.
- It directly helps in reduction of traffic congestion, Reduction in Environmental pollution and Reduction in Travel Time.
- Based on the feedback and Willingness to pay survey, it is concluded that the regular trip makers are of the opinion to adopt System like Monorail, which ultimately helps in saving environment and less travel time.
- Current Mass Transportation System like AMTS, GSRTC is not performing satisfactorily due to improper and inadequate service and Poor maintenance. It increase amount of pollution.
- People will adopt the system which is environment friendly, cheap, time saving and comfort level of service.

5. Economic analysis

5.1 Economic Analysis Approach

The economic evaluation of the Monorail system has been carried out within the broad framework of Social Cost–Benefit Analysis method. It is based on the incremental costs and benefits and involves comparison of project costs and benefits in economic terms under the "with" and "without" project scenario. In the analysis, the cost and benefit streams arising under the above project scenarios have been estimated in terms of market prices and economic values have been computed by converting the former using appropriate shadow prices.

5.2 Estimation of Costs

The monorail project cost comprises capital cost, operation and maintenance cost.

- Capital cost of infrastructure (civil engineering, land, track, power supply, traction system, signaling and telecommunications, etc.) and rolling stock.
- Operating cost of Monorail
- Table summarizes the estimated cost (Rs. in Crores) to economy. For Monorail, it is estimated around 100 Crores assuming escalation factor of 5%.

5.3 Estimation of Benefits

Travel Time Saving Peoples give importance in reductions in waiting time and in vehicle travel time. The Monorail will reduce waiting and travel time. Monorail system is considered to be a rapid

transit system so it will reduce the travel time of commuter significantly rather than travelling other mode of travel.

Travel Time Saving Calculation

Section	C	2W	3W	B
Sarkhej -Pakwan	25074	21833	11659	1214
Pakwan-Thaltej	27276.	19087	4800	680
Thaltej-Cambay	29985	12486	5075	1276
Cambay-Gota	10488	16921	7874	89
Gota-Vaishnodevi	92823	70327	29407	3258
Vaishnodevi-Infocity Circle	49256	29488	10283	856
Total Vehicles	**234903**	**170142**	**69098**	**737**

Table 5.8 Fare Structure

Distance in Km	fare Rs.	Distance in Km	fare Rs.
0..2	7	2-4	7
4- 6	9	6-8	11
8-10	13	10-12	15
12-14	17	14-16	19
16-18	21	18-20	23
20-22	25	22-24	27
24-26	29	26-28	30
28-30	30	30-32.2	30

From the calculation based on the data, minimum revenue generation on the corridor is about Rs. 7914566. The anticipated revenue generation per year from fare is about Rs. 289 crores per year.

Pollution control and damage cost

Table 5.9 fuel Consumption

Type of Vehicle	Idle fuel Consumption in Litre per Hour
2 W	0.34
3 W	0.42
Car	0.54
Buses	0.86

Source: PCRA Study 1996

Table 5.10 Total benefits

Benefit Type Benefit Value (Rupees)	Benefit Type Benefit Value (Rupees)
Value of Travel time saving to riders	71752614

Reduction in Vehicle operating cost	1790819677
Revenue Generation from Fares	1444408181
Pollution Cost	1790819677
Increases of Road Capacity	Not Quantified
Reduction in Accidents	Not Quantified
Increases Comfort and services	Not Quantified
Development near Stations	Not Quantified
Society pleasure	Not Quantified
Total Benefits	6096424331 per Year

Table 5.11 Benefits- Cost Analysis

YEAR	BI	CI	BI-CI	BI-CI/(1+I)N	REMARK
2015	0	3961	-3961	-3961	0
2016	610	4	606	541.071429	1
2017	613.05	4	609.05	485.530931	2
2018	616.1153	4	612.1153	435.691544	3
2019	619.1958	4	615.1958	390.968069	4
2020	622.2918	4	618.2918	350.835375	5
2021	625.4033	4	621.4033	314.822233	6
2022	628.5303	4	624.5303	282.505782	7
2023	631.6729	4	627.6729	253.50657	8
2024	634.8313	4	630.8313	227.48409	9
2025	638.0055	4	634.0055	204.132788	10
2026	641.1955	4	637.1955	183.178474	11
2027	644.4015	4	640.4015	164.375104	12
2028	647.6235	4	643.6235	147.501886	13
2029	650.8616	4	646.8616	132.360696	14
2030	654.1159	4	650.1159	118.773743	15
2031	657.3865	4	653.3865	106.581487	16
2032	660.6734	4	656.6734	95.6407649	17
2033	663.9768	4	659.9768	85.8231086	18
2034	667.2967	4	663.2967	77.0132365	19
2035	670.6331	4	666.6331	69.1077007	20
				4666.90501	

Cost of Project= 123 Crores per km * 32.2 km = 3961 crores.

Benefit/Cost Ratio= 4667/32.2 = 1.18 greater than 1

The cost and benefit analysis for 20 year period in the economic prices is worked out and presented in Table. The maintenance cost of the total project is considered as 2. The calculated benefit – cost ratio is 1.18, which is greater than 1. Hence the project is justified.

6. CONCLUSION

The major results and findings achieved from the study can be pointed out in brief as follows.

- The proposed corridor is taken from section Sarkhej Circle to Gandhinagar (Pathika) will set aside safe and efficient movement of vehicles and minimize the environmental impact of traffic, on the surrounding areas.
- From the Economic analysis carried out on the corridor the cost and benefit streams for 20 year period in the economic prices have been worked out. The calculated benefit –cost ratio is 1.18, which is greater than 1. Hence the project is economically justified
- From the predicted ridership on the corridor the fleet and scheduling has been done and guidelines for scheduling has been given and the frequency between two monorails is considered as 15 minutes.
- The Economic analysis shows that the monorail's benefits are more than the cost and the proposed monorail is a prudent investment in transportation capacity for the proposed Corridor. The project generates benefit–cost ratio of 1.18.The net benefits of the project are in excess of Rs. 4667 crores.

7. LIMITATIONS

The study is limited to Sarkhej Circle to Gandhinagar (Pathika). The findings of the study are based on primary survey conducted because of lack of data on travel characteristics along the corridor. The given time frame permitted a small size of data collection as compared to those required for transportation modeling for predicting rider ship. Forecasting based on limited past data, more robust travel demand data required.

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