PERFORMANCE EVALUATION OF BRTS BY USING AHP MODEL

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Abstract: *This paper presents the development of bus route evaluation system, for a public bus transportation system in Rajkot city of Gujarat. Bus mass rapid transit System (BRTS) is an innovative, high capability, lower price transport solution which will considerably improve urban quality. Transport System in most Indian cities is rapidly deteriorating due to the increasing travel demand and inefficient transportation. There square measure numerous issues connected with transport such tremendous increase in range of accidents, Environmental degradation, Congestion, Overcrowding as a result of inadequate system, Frequency of service and schedule isn't strictly adhered. the matter of pollution, safety and unskillfulness have reached at an awful level in most of the key cities in Bharat as a result of intense growth of its population -both of individuals and motorcars, combined with inefficient transport system and poor social control of environmental laws etc. Analytic Hierarchy Process (AHP) model is used, which integrates quantitative and qualitative attributes of the bus routes.*

KEY WORDS: **BRTS, qualitative & quantitative criteria, AHP model.**

[1] INTRODUCTION

A 'smart city' is an urban region that makes optimal use of resource to better control and operations which ensures competitiveness, sustainability and quality of. Consequently, the government has now realized the need for 100 smart cities in India in urban areas [MoUD, Draft report, 2016]. However, the development of smart cities should be in such a way so that it provides optimal use of available transport facilities. Bus rapid transit system (BRTS) is a key component which plays a key role in development of smart cities in any developing countries including India from social as well as economic point of view. It is a most cost-effective, high capacity, comparatively flexible, easily accessible and innovative system that can significantly improve the performance of transport system in urban and suburban environments. At present there are number of BRT systems running in various Indian cities like Delhi, Ahmadabad, Pune, Indore, Bhopal, Jaipur, Surat and Rajkot. It is observed that almost all developing countries including India faced problem of congestion, delay, accident and pollution due to intensified growth of private vehicles. Hence, in most of Indian cities due to cost from congestion and delay have a huge economic loss of individual as well as bus rapid transit operators both. Therefore it is necessary to evaluate the comparative performance of BRTS in existing cities to how well it is providing transport service to the public in the area served, and provides valuable information based on which important operating decisions can be taken.

[2] LITERATURE REVIEW

1. "*Performance Analysis of BRT System Surat" by Tisa v. Agarbattiwala & Bhasker Vijaykumar Bhatt*

Their objective of study was to analyze performance of BRTS to encourage people to use BRTS efficiently. They analyzed system by service quality and user satisfaction survey. They took two corridors for study and they got passenger travel information from records of tickets issued from each of the bus stations for the duration of November 2015 till

February 2016 – a time passage of 4 months. They did this exercise for both corridors for same time duration. Then they took sample survey considering total population travelling in the Surat BRTS. The respondents were requested to provide responses through a questionnaire seeking details and exercise resulted in formulation of an O-D Matrix for groups of stations. Based on the O-D Matrix, maximum daily trip occur from different group of stations were figured out. And different questions responded by the commuters during the user-satisfaction survey were compiled and analyzed.

2. "*Micro Simulation Based Performance Evaluation of Delhi Bus Rapid Transit Corridor" by Gautam Raj G, Ch. Ravi Sekhar and S. Velmurugan*
They collected data of traffic volume by CVC survey at all the intersection, speed and delay data by conduction survey using Probe Vehicle Method by fitting GPS during different time periods so as to account for the peak and inter peak hour traffic separately, signal phasing data was collected at all the intersections on study area to know the cycle lengths at different intersections and its corresponding number of phases. These parameters mainly include vehicular characteristics, traffic flow composition, desire speed distributions, vehicle flows and composition, and driving behavior parameters namely car-following and lane change behavior. And they developed performance models in the form of Speed versus Volume-Capacity ratio.

3. "*Evaluation of BRTS corridor in India Using Microscopic Simulation: A Case study in Surat city" by Akhilesh Chepuri, Rakesh Kulakarni, Manraj Singh Bains, Shriniwas Arkatkar and Gaurang Joshi*
The work aims to evaluate the delays caused to the traffic at intersections using the microscopic simulation software, VISSIM 7.0.The work also comprises of system performance evaluation of BRTS, which includes investigation on causes of delay and overall its impact on the BRTS.The study is carried out for suggesting the feasible traffic management measures, which may result in reduction of delay and travel time to both BRTS buses and private traffic, which may eventually result in emissions reduction.

4. "*BRTS Performance And Evaluation Of Vishakhapatnam" by M Sudheer Babu and V. Mahalakshmi Naidu*
Their study area was PTC corridor- Pendurthi to Dwarakanagar via NAD junction (22.60km).And STC corridor-Pendurthi to Dwarakanagar via simhachalam (20.40 km). They carried out traffic volume studies. They evaluated system on the basis of traffic volume studies, journey speed studies and average spot speed studies.

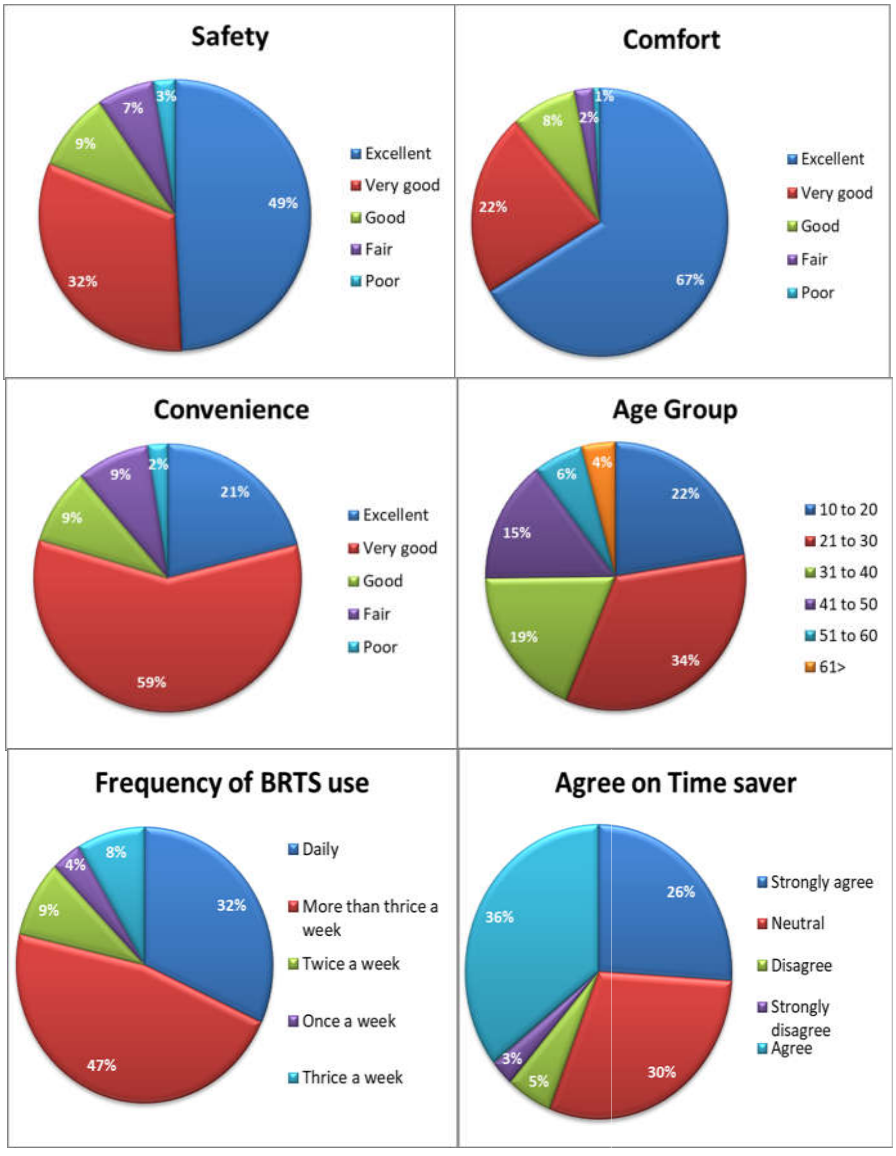
5. "*Performance Evaluation of Bus Routes using AHP" by R. Baskaran and K. Krishnainah*
This paper presents the development of bus routes evaluation system for a public transport system in Chennai city. They built AHP model, which integrates quantitative and qualitative attributes of the routes. The model consists 5 main criteria and 18 sub criteria on the basis of discussion with bus operators and passengers and also referring to literature. Major objective was to requisite decision for regulating routes. They collected data from passengers travelling in the route and the officials working in the depot of MTC, Chennai. For prioritization procedure they designed questionnaire and collected 50 samples, including both passengers and management personnel. Then data converted by normalization and inserted into PCM and after comparison they gave final ranking of the routes of the selected bus depot.

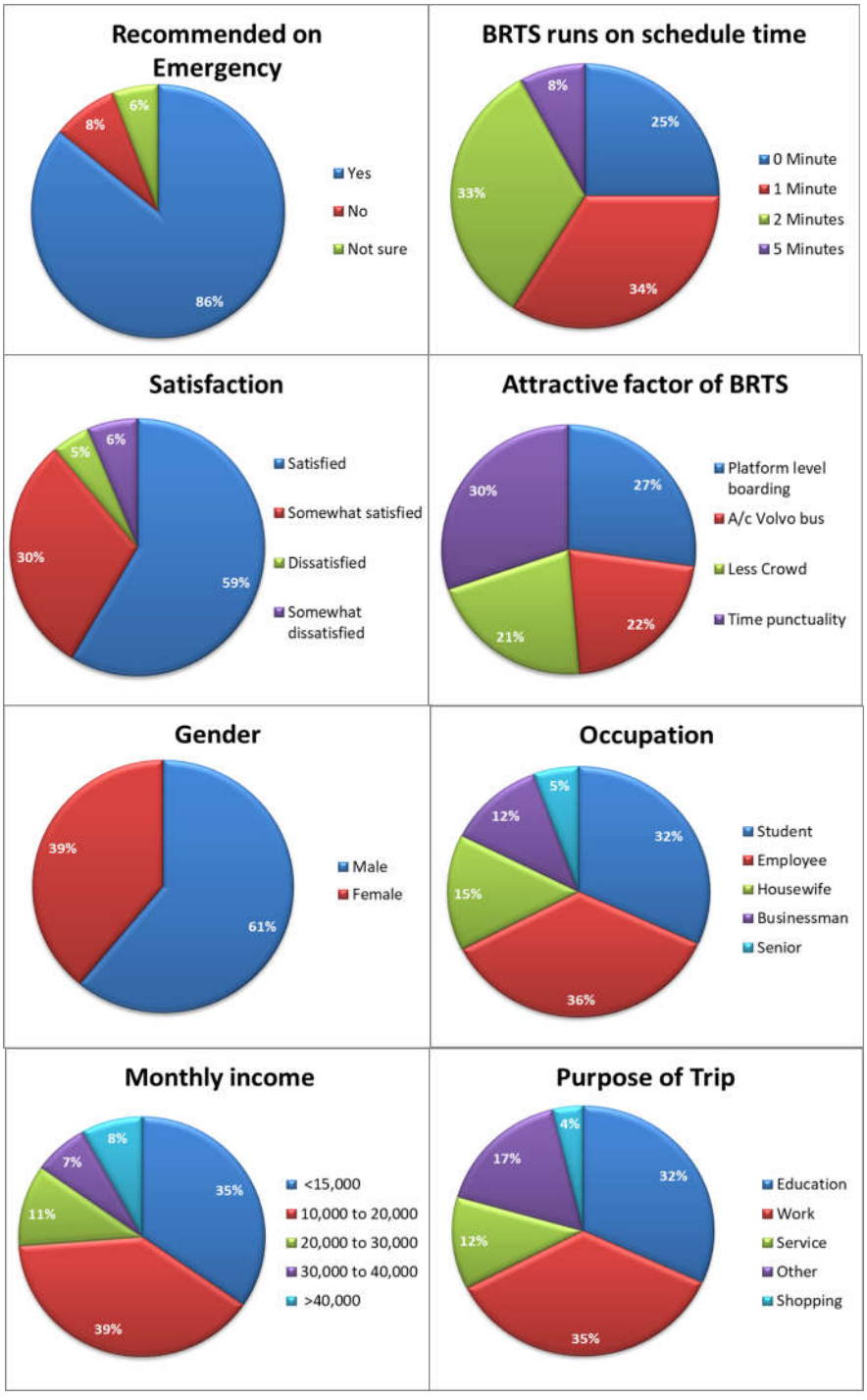
[3] DATA COLLECTION AND ANALYSIS

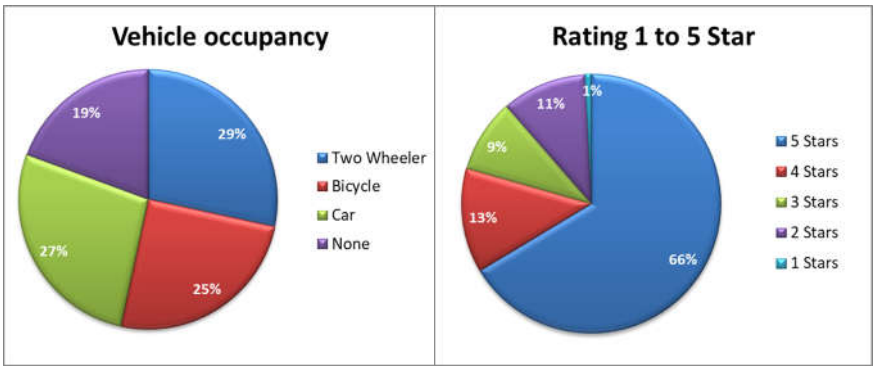
For the purpose of this study, all the required data taken on from the commuters using BRTS on a stretch from Gondal chokdi to Madhapar chokdi by questioner form.

Parameters:

Qualitative Criteria	Quantitative Criteria
Safety	Schedule reliability
Comfort	Service frequency
Convenience	Bus hour utilization
	Average passenger per trip
	Average travelling speed




Recommended on Emergency
6%
8%
86%
Yes
No
Not sure
BRTS runs on schedule time
8%
25%
33%
34%
0 Minute
1 Minute
2 Minutes
5 Minutes
Satisfaction
6%
5%
30%
59%
Satisfied
Somewhat satisfied
Dissatisfied
Somewhat dissatisfied
Attractive factor of BRTS
30%
27%
21%
22%
Platform level boarding
A/c Volvo bus
Less Crowd
Time punctuality
Gender
39%
61%
Male
Female
Occupation
5%
12%
32%
15%
36%
Student
Employee
Housewife
Businessman
Senior
Monthly income
8%
7%
35%
11%
39%
<15,000
10,000 to 20,000
20,000 to 30,000
30,000 to 40,000
>40,000
Purpose of Trip
4%
17%
32%
12%
35%
Education
Work
Service
Other
Shopping



Case – 1 : Actual case

Qualitative Analysis:

Sr.	Criteria	Excellent	Very Good	Good	Fair	Poor
1	Safety	246	160	47	34	13
2	Convenience	105	293	46	44	12
3	Comfort	332	111	41	12	4

Criteria	Safety	Comfort	Convenience
BRTS route	Excellent	Excellent	Very good

Quantitative Analysis:

Criteria	Schedule reliability	Service frequency	Bus hour utilization	Avg. passenger/trip	Avg. travelling speed
Result	Excellent	Excellent	Fair	Very good	Very good

Pair Wise Comparison of criteria:

Criteria	Safety	Comfort	Convenience	Schedule reliability	Service frequency	Bus hour utilization	Avg. Passenger per trip	Avg. travelling speed
Safety	1	1	3	1	1	7	3	3
Comfort	1	1	3	1	1	7	3	3
Convenience	1/3	1/3	1	1/3	1/3	5	1	1
Schedule reliability	1	1	3	1	1	7	3	3
Service frequency	1	1	3	1	1	7	3	3
Bus hour utilization	1/7	1/7	1/5	1/7	1/7	1	1/5	1/5
Avg. Passenger per trip	1/3	1/3	1	1/3	1/3	5	1	1
Avg. travelling speed	1/3	1/3	1	1/3	1/3	5	1	1

Criteria	Safety	Comfort	Convenience	Schedule reliability	Service frequency	Bus hour utilization	Avg. Passenger per trip	Avg. travelling speed
Safety	1	1	3	1	1	7	3	3
Comfort	1	1	3	1	1	7	3	3
Convenience	0.33	0.33	1	0.33	0.33	5	1	1
Schedule reliability	1	1	3	1	1	7	3	3

Service frequency	1	1	3	1	1	7	3	3
Bus hour utilization	0.14	0.14	0.20	0.14	0.14	1	0.20	0.20
Avg. Passenger per trip	0.33	0.33	1	0.33	0.33	5	1	1
Avg. travelling speed	0.33	0.33	1	0.33	0.33	5	1	1
Total	**5.13**	**5.13**	**15.20**	**5.13**	**5.13**	**44**	**15.20**	**15.20**

Normalization:

Criteria	Safety	Comfort	Convenience	Schedule reliability	Service frequency	Bus hour utilization	Avg. Passenger per trip	Avg. travelling speed	Total	Average	Consistency measure
Safety	0.19	0.19	0.20	0.19	0.19	0.16	0.20	0.20	1.53	0.19	8.13
Comfort	0.19	0.19	0.20	0.19	0.19	0.16	0.20	0.20	1.53	0.19	8.13
Convenience	0.06	0.06	0.07	0.06	0.06	0.11	0.07	0.07	0.57	0.07	8.08
Schedule reliability	0.19	0.19	0.20	0.19	0.19	0.16	0.20	0.20	1.53	0.19	8.13
Service frequency	0.19	0.19	0.20	0.19	0.19	0.16	0.20	0.20	1.53	0.19	8.13
Bus hour utilization	0.03	0.03	0.01	0.03	0.03	0.02	0.01	0.01	0.17	0.02	8.00
Avg. Passenger per trip	0.06	0.06	0.07	0.06	0.06	0.11	0.07	0.07	0.57	0.07	8.08
Avg. travelling speed	0.06	0.06	0.07	0.06	0.06	0.11	0.07	0.07	0.57	0.07	8.08
Total	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**8**	**1**	**64.76**

Case – 2: Avg passenger/trip and Avg. travelling speed taken excellent:

Criteria	Safety	Comfort	Convenience	Schedule reliability	Service frequency	Bus hour utilization	Avg. Passenger per trip	Avg. travelling speed	Total	Average	Consistency measure
Safety	0.15	0.15	0.16	0.15	0.15	0.15	0.15	0.15	1.23	0.15	8.06
Comfort	0.15	0.15	0.16	0.15	0.15	0.15	0.15	0.15	1.23	0.15	8.06
Convenience	0.05	0.05	0.05	0.05	0.05	0.10	0.05	0.05	0.46	0.06	8.03
Schedule reliability	0.15	0.15	0.16	0.15	0.15	0.15	0.15	0.15	1.23	0.15	8.06
Service frequency	0.15	0.15	0.16	0.15	0.15	0.15	0.15	0.15	1.23	0.15	8.06
Bus hour utilization	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.16	0.02	8.00
Avg. Passenger per trip	0.15	0.15	0.16	0.15	0.15	0.15	0.15	0.15	1.23	0.15	8.06
Avg. travelling speed	0.15	0.15	0.16	0.15	0.15	0.15	0.15	0.15	1.23	0.15	8.06
Total	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**8**	**1**	**64.36**

Case – 3: Bus hour utilization taken good:

Criteria	Safety	Comfort	Convenience	Schedule reliability	Service frequency	Bus hour utilization	Avg. Passenger per trip	Avg. travelling speed	Total	Average	Consistency measure
Safety	0.19	0.19	0.20	0.19	0.19	0.17	0.20	0.20	1.52	0.19	8.07
Comfort	0.19	0.19	0.20	0.19	0.19	0.17	0.20	0.20	1.52	0.19	8.07
Convenience	0.06	0.06	0.07	0.06	0.06	0.10	0.07	0.07	0.55	0.07	8.03
Schedule reliability	0.19	0.19	0.20	0.19	0.19	0.17	0.20	0.20	1.52	0.19	8.07
Service frequency	0.19	0.19	0.20	0.19	0.19	0.17	0.20	0.20	1.52	0.19	8.07
Bus hour utilization	0.04	0.04	0.02	0.04	0.04	0.03	0.02	0.02	0.25	0.03	8.00
Avg. Passenger per trip	0.06	0.06	0.07	0.06	0.06	0.10	0.07	0.07	0.55	0.07	8.03
Avg. travelling speed	0.06	0.06	0.07	0.06	0.06	0.10	0.07	0.07	0.55	0.07	8.03
Total	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**8**	**1**	**64.39**

Calculation of priority value for all the three cases

Sr.	Description	Value
1	Case – 1	0.43746
2	Case – 2	0.46874
3	Case – 3	0.44014

[4] Result and Conclusion:

In this study, a bus route evaluation criteria for a bus transit system consisting of two major criteria and eight sub criteria are identified and an AHP model has been designed. The model has been employed to evaluate one operational route. Sensitivity analysis has been carried out to examine how sensitive the criteria's are to changes in the importance of objective. Quantitative and qualitative both criteria majorly influence the performance of current BRTS route as shown in actual case. In second case and third case as well less-influenced criteria evaluated. Its evaluation and impact and influence shown in a case-2 and case-3 on overall performance of BRTS on this route. And priority values for all three cases were calculated and changes were found accordingly.

So by concentrating on these aspects of the study, one can get thorough understanding of criteria that influence the performance of BRTS route and by further demand analysis and improvement can shift use from the personal mode of transport toward a lot of economical and safe transport system.

[5] References

1. *"Performance Analysis of BRT System Surat"* by Tisa v. Agarbattiwala & Bhasker Vijaykumar Bhatt-International Journal of Engineering Research-2016

2. *"Micro Simulation Based Performance Evaluation of Delhi Bus Rapid Transit Corridor"* by Gautam Raj G, Ch. Ravi Sekhar and S. Velmurugan-ScienceDirect-2013

3. *"Evaluation of BRTS corridor in India Using Microscopic Simulation: A Case study in Surat city"* by Akhilesh Chepuri, Rakesh Kulakarni, Manraj Singh Bains, Shriniwas Arkatkar and Gaurang Joshi-ResearchGate-2015

4. *"BRTS Performance And Evaluation Of Vishakhapatnam"* by M Sudheer Babu and V. Mahalakshmi Naidu-International Journal of Traffic and Transportation-2017

5. *"Performance Evaluation of Bus Routes using AHP"* by R. Baskaran and K. Krishnainah-European Journal of Science Research-2011

6. Rajkot Municipal Corporation www.rmc.gov.in

7. www.wikipedia.org

8. www.janmarg.in