Enhancing Public Transportation System in Ahmedabad City: A Case Study of AMTS

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***Abstract*—An efficient transit planning system must include bus route evaluation as it offers crucial information for important operational choices. These might involve removing a route, combining routes, or adding new routes in order to improve overall service effectiveness. The goal of this research is to identify current issues and problems with bus route operations so that well-informed decisions can be made for improvement. Since route performance significantly influences the effectiveness of bus transportation, there is a need for a robust model to assess route efficiency comprehensively. Multiple factors—both quantitative (for example, the distance between bus stops, fuel usage, and timeliness) and qualitative (including road conditions, safety, and passenger comfort)—impact route performance. The study suggests using a Multifaceted Decision-Maker (MCDM) approach to account for this difficult evaluation. The Analytical Hierarchy process (AHP) is specifically used because it successfully combines qualitative and quantitative criteria. For the purpose of analysis, five bus routes from the Ahmedabad Municipal Transport Service (AMTS), out of a total of 308 routes, were selected. The developed AHP-based evaluation model successfully ranked these routes from best to worst, offering a structured and objective assessment of their operational performance.**

Key Words —Analytic Hierarchy Process (AHP), Decision Markings, and Multiple Criteria.

I. INTRODUCTION

India's rapidly growing metropolitan landscape is confronting serious transportation issues as a result of growing population, increased automobile congestion, and environmental concerns [1] [2]. Efficient public transport networks are essential for sustaining urban expansion, improving mobility, and reducing traffic congestion. The largest city in Gujarat, Ahmedabad, faces similar challenges as its population grows and further strains the state's transit infrastructure. One of the most important parts of the city's public transport system, the Ahmedabad Municipal Transport Service (AMTS), is examined in this research along with its history, effects, and difficulties. AMTS has ensured that the city's citizens have access to reasonably priced and reliable transit since its founding in 1947. In order to satisfy the increasing expectations of Ahmedabad's citizens, the study aims to assess AMTS's present performance, look into possible areas for improvement, and analyses how the system has aided in the city's mobility. However, with the rapid urbanization of Ahmedabad, AMTS has faced significant pressures, ranging from outdated infrastructure, overcrowding, and competition from other forms of transportation like auto-rickshaws, private vehicles, and ride-hailing services. In order to improve the system's overall sustainability and efficiency, the research will also examine best practices from other cities, offer helpful recommendations, and take into account incorporating cutting-edge technology like smart tickets, GPS monitoring, and electric buses. As a case study, AMTS may be used as a template to build a more resilient, efficient, and sustainable public transportation system that can accommodate the demands of a contemporary, quickly growing metropolis such as Ahmedabad. This essay will offer a thorough comprehension of this procedure. The ultimate goal is to offer ideas for improving the efficiency and utility of public transit while also contributing to the development of a more sustainable urban future.

II. LITERATURE REVIEW

Mahesh L. Chaudhary “Commuters’ Perceptions on Service Quality of Bus Rapid Transit Systems: Evidence from the Cities of Ahmedabad, Surat and Rajkot in India” There are nine demographic cohorts used in the study. The efficiency of the city's bus rapid

transit systems has been examined using the SERVPERF model. Six criteria are used to evaluate the performance: tangibles, affordability, safety, dependability, cleanliness, and empathy. When it came to many dimensions of service quality, Surat outperformed the other two cities, followed by Rajkot and Ahmedabad. Additionally, commuter perceptions of quality of service features differ among demographic groups, including gender, travel time, education, employment level, duration of patronage, and trip purpose [3].

Priyanka P. Mehta "enhancing public transit users' satisfaction and perceived service quality by using importance – performance analysis approach – a case study of Rajkot city" The in-depth design of the survey based on the primary survey result. RIDIT and Importance-Performance analysis were used for the analysis. The RIDIT approach is utilized when ranking attributes. IPA was able to examine service quality, key service characteristics, and where to concentrate on improvement efforts. The level of service indicators for Rajkot city have been developed on the basis of the MOUD service level benchmark. RMTS has been evaluated using RIDIT, IPA, and level of service indicators [4].

Eshetie Berhan, Birhanu Beshah Daniel Kitaw "Performance Analysis on Public Bus Transport of the city of Addis Ababa" The fleet's operational performance is taken into consideration while calculating the percentage load factor (plf), passengers carried per vehicle per day (ppvpd), and kilometres travelled per vehicle per day (kpvpd) [5].

Mayursinh Jadeja B, Patel Bindiya N, Monicaba Vala "Performance Evaluation of RMTS Bus Routes by using Multi Criteria Decision making Method" As public transport speeds down, congestion increases, and its economic viability declines, it becomes a source of environmental problems. The evaluation determined the operational conditions and current problems in order to give an objective foundation for the necessary regulatory decisions, such as removing a route, merging routes, or creating new routes aimed at enhancing service and efficiency [6].

Gaurav V. Jaina, S.S. Jainb , Manoranjan Parida "Evaluation of travel speed of conventional buses and bus rapid transit service in Ahmedabad city, India using geo-informatics" The two public transport options in Ahmedabad are the Ahmedabad Janmarg Ltd.'s BRTS and the Ahmedabad Municipal Transport Service's (AMTS) regular fixed-route bus service. (AJL). AMTS transports 562,000 passengers daily on average across 203 routes in the city, including a 3379-kilometer route (AMC, 2020) [7].

Will, Marie-Eve, Cornet, Yannick, Munshi, Talat "Measuring road spaces consumptions by transport modes: Toward a standard spatial efficiency assessment methods and an application to the development scenarios Rajkot City, India" The first part of Section 2 describes how the suggested paradigm for evaluation incorporates findings from earlier research on transport spatial assessment. This section presents the comprehensive approach that was created to quantify space for both parking and moving traffic. Section 4 presents measures for several forms of transport for each of the Rajkot development scenarios [8].

Rena N. Shukla " Analysis of Passenger Trips by Public Transport – Bus Transit in West Zone of Ahmedabad" A mode of transportation known as public transportation (PT), also referred to as public transportation, mass transit, or simply transit, is Rail transit and bus transit are the two types of public transportation available. It is for systems of group travel that are accessible to the general public for use. It operates on predetermined routes and is managed according to a schedule [9].

Thomas L. Saaty "Decision making with the analytic hierarchy process" Define the issue and the type of information sought. The goal of the decision should be at the top of the decision hierarchy, followed by the objectives from a broader perspective. The intermediate levels should be criteria on which the subsequent elements are based, and the lowest level should be a set of the alternatives Create a collection of matrices for pairwise comparison. Using the elements from the upper level, the elements in the level below are compared to one another. The priorities derived from comparisons should be used to weigh the priorities at the level below them. Do this for each component. The overall or global priority can then be calculated by adding the weighted values of each element in the level below. Keep doing this process of weighing and adding until you get the final priorities for the options at the lowest level [10].

Madhav G. Badami, Murtaza Haider "An analysis of public bus transit performance in Indian cities" There are a number of negatives effected that have resulted from the rapid increase in motor vehicle activity in Indian cities. Traffic congestion is increasing rapidly, causing significant time and productivity losses [11].

Faizi Ahmad Javeed, Juremelani Jayesh R. and Bagadia Sanket "Evaluation of Commuters' Travel Behavior under Mix Traffic Condition: A Case study of Vadodara City" After Surat and Ahmedabad, Vadodara is ones of the largest cities in the Indian state of Gujarat. This city is also known as Baroda. One of India's most multicultural cities, Vadodara is in the south-east of Ahmedabad. The area is also known as the "City of Culture" or "Sanskar Nagri." As per 2019 estimated population is mentioned 20,065,771 inhabitants living in 12 tehsils, 15 towns, and 1,548 villages [12].

Mayank P Patel, H.K Dave, V.R Gor, V.M Patel "Impact of Irregularity and Loss of Punctuality on the Performance of Public transportation System" In the paper, service regularity and punctuality are used to evaluate terminal and route performance [13].

Mahmod Othman, Ku Ruhana Ku Mahamud " Fuzzy Multi Criteria evaluation for Performance of Bus Companies" The research proposes multi-criteria decision markings for rating bus firms using fuzzy rule. (2000) on ten Taipei, Taiwan-based bus companies. Security and comfort The criteria used to rank the performance of bus companies include service descriptions and attributes, as well as convenience operation and social responsibility [14].

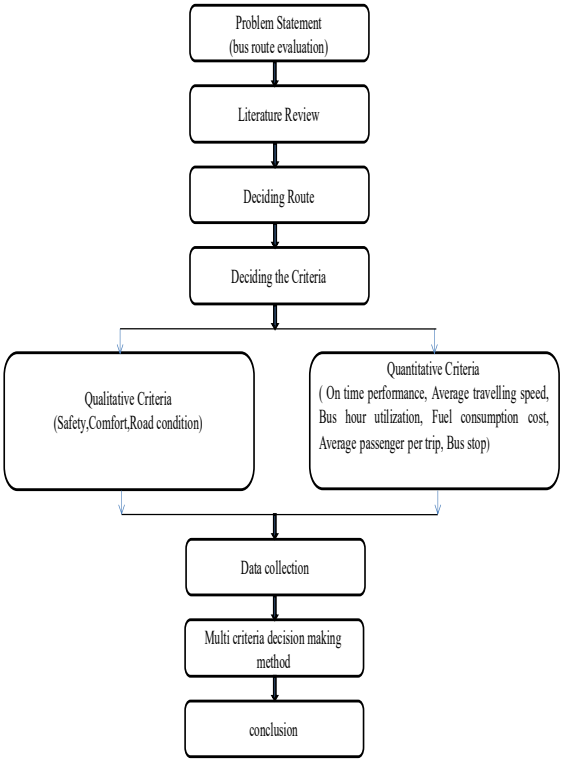
III. OBJECTIVE OF STUDY

1. To evaluate the social and economical characteristics of bus commuters.
2. To evaluate the existing demand pattern of bus commuter.
3. To evaluate the different factor affects the urban bus transport.
4. To recommend improvement in existing bus routes.

IV. SCOPE OF STUDY

1. Study is limited to AMTS.
2. Out of 308 Routes 5 route are Selected for the study in Ahmedabad City.
3. For bus route evaluation 9 criteria are selected with combination of qualitative and quantitative criteria Ahmedabad.

V. METHODOLOGY



VI. DATA COLLECTON

This study aims to gather both qualitative and quantitative data from bus commuters using a questionnaire and five specific routes in Ahmedabad: Route No. 66/4: Kush Society (New Naroda) to Arvind Polycot (Khatraj Chowk) Via; Route No. 40/2: Rajoda Patiya to Ranip Gam (DOWN) (I.T.M.S.); Route No. 124: Maninagar to Eng./B.Ed. College (Vaghela) (UP) (I.T.M.S.); Route No. 144: Arbudanagar to Gujarat University via; and Route No. 3sh: Balahanuman Express (Circular Route) Bhadrakali Mandir to Bhadrakali Mandir Via. Included in the survey form is a parameter.

Table 1: Parameter

1	The gender
2	Age range
3	Kinds of housing
4	Number of families member
5	Number of licensed holder
6	Monthly household incomes
7	Own vehicles
8	The reason for the journey
9	There is para-transit available.
10	Areas of origin and destination
11	Regularity of visits to AMTS
12	Used the monthly pass for AMTS
13	Holding out for the bus
14	Bus at walking distance
15	When you're seated
16	Issues with theft

VII. THE METHOD OF DATA ANALYSIS

1. Analytic Hierarchy Process (AHP)
- Make a hierarchy out of the decision-making dilemma.
- Prioritise the elements of the hierarchy and compare pairs by pairs.
- Developing judgement entails gaining the comprehensive viewpoint or weighing need to accomplish your goal.
- Assess and confirm the consistency of judgement.
- A pairwise comparison matrix is created for each condition.
- Final matrix normalization.
- The appropriate rating may be achieved by averaging the numbers in each row.
- Consistency ratios are calculated and evaluated.
- Calculate the weighted averages for every option. The individual with the highest marks should be chosen.

2. Structure of The Hierarchy
- Organism the decision-making task into a list of criteria and choices according to their relative significance.
- The aim of the analysis is to achieve Level 1. Multiple layers of sub-criteria can be added to Level 2, which is multi-criteria. The options make up the final level.

VIII. DATA ANALYSIS

1) Quality Assessment of Every Route Number

Table 2: Quality Assessment of Every Route Number

2) Quantitative Evaluation and Calculation for Every Path

1. The on time performance = ((5*94)+(10*7))/ (94+7)

Route no.	Safety	Comfort	Road condition
66/4	Good	Very Good	Excellent
40/2	Very Good	Very Good	Good
124	Good	Good	Excellent
144	Good	Very Good	Excellent
3sh	Very Good	Excellent	Excellent

2. The cost of fuel:
   1. Assume 6 km/kg of fuel efficiency.
   2. Assume that the fuel cost is 80.48 rupees per kilogram.
   3. Idel fuel usage is 0.4 kg per hour.
3. Total route length in kilometers divided by the number of bus stops equals bus stop spacing (in meters) x 1000.
4. The bus hour utilization is calculated by dividing the total travel time by the frequency and the number of buses on that route by the working hour [6].
5. Average journey speed is calculated as (Total travel distance (km)) / (Average travel time (hr.)) [6].
6. The average number of passengers per trip is equal to the bus's seating capacity plus the number of standing passengers.

3) Quantitative Evaluation of All Routes

Table 3: Quantitative Evaluation of All Route

Route no	1	2	3	4	5	6
66/4	5.35	14.70	404	0.65	12.24	55
40/2	8.20	14.17	384	0.41	12.14	64
124	7.97	14.19	375	0.36	13.87	79
144	14.44	14.30	338	0.45	15.55	68
3sh	7.27	14.63	262	0.87	13.75	53

IX. SELECTING THE BEST ROUTES WITH AHP

1. All Routes Are Ranked

Table 4 : All Routes Are Ranked

Name of the route	Priority value	Ranking
Arvind Polycot	0.094	2
Ranip Gam	0.086	3
B.Ed. College	0.080	5
Gujarat University	0.083	4
Bhadrakali Mandir	0.126	1

X. CONCLUSION

1. According to the study's socioeconomic analysis, the majority of passengers travel daily for work and educational trips.
2. It also shows that most passengers have their own vehicles themselves. This suggests that people still favor public transportation even when they own their own cars.
3. As a result, it suggests that public transportation has enormous potential.
4. Given that the average user is between the ages of 15 and 34 and the average trip length is between 20 and 26 kilometers, it is determined that special bus models with more standing room and fewer seats should be introduced in order to comfortably accommodate a greater number of passengers. with the exception of student-only route 124.
5. Our judgments are extremely close to perfection because our consistency ratio value was very low.

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