Performance Evaluation and Service Quality in Public Transportation

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Abstract—A key element of efficient transit system development is bus route evaluation. Important insights that guide important operational choices are produced by this process. Transit agencies can identify present problems and evaluate operational conditions by evaluating their routes. Decisions like route elimination, merger, or introduction are supported by this objective analysis, which also improves overall service quality and operational effectiveness. The performance of individual routes has a significant impact on the public bus system's efficacy. Thus, the goal of this research is to create a model that can evaluate route performance. A Multi-Criteria Decision Making (MCDM) technique is considered appropriate as route performance is affected by a number of parameters, both quantitative (such as fuel efficiency, timeliness, and stop distance) and subjective (such as road condition, passenger comfort, and safety). The Analytic Hierarchy Process (AHP), one of the numerous MCDM approaches, is especially suitable since it takes into account both qualitative and quantitative data. Out of the 48 routes run by RMTS, five were chosen for investigation in this study. The algorithm rates these five routes according to their overall efficacy using the performance metrics that have been defined.

Index Terms—Decision Marking, Multi Criteria, Analytic Hierarchy Process (AHP)

I. INTRODUCTION

A significant portion of the population can move around thanks to public transit, which is an essential part of urban infrastructure that also promotes economic growth and environmental sustainability. [1] [2] The effectiveness and calibre of public transport systems have a big influence on citizens' everyday life in expanding cities like Rajkot. The main public transport system in the city is the Rajkot Municipal Transport Service (RMTS), which strives to provide dependable, easily accessible, and reasonably priced mobility options. To make sure RMTS fulfils commuter expectations and advances the city's larger development objectives, it is crucial to assess its performance and service quality. Analysing important operational parameters including safety, price, coverage, regularity, and timeliness is part of performance evaluation. Service quality, on the other hand, is concerned with how passengers perceive certain elements, such as convenience, cleanliness, staff conduct, and comfort. The purpose of this study is to evaluate RMTS's operational effectiveness as well as the perceived level of service quality in Rajkot. In order to provide recommendations for improving the efficiency and user happiness of the city's public transport system, the research will combine quantitative performance statistics with qualitative user input to identify areas of strength and development.

II. LITERATURE REVIEW

Due to rising car traffic, environmental concerns, and population growth, India's rapidly expanding metropolitan landscape is facing significant transportation challenges. Reducing traffic, enhancing mobility, and maintaining urban growth all depend on effective public transportation systems. Similar issues arise in Ahmedabad, Gujarat's largest city, as the state's transit system is further taxed by an expanding population. A Multifaceted Decision-Maker (MCDM) approach is recommended by the study to take into consideration this challenging assessment. Because the Analytical Hierarchy process (AHP) effectively blends qualitative and quantitative criteria, it is especially utilised. Out of the 308 bus routes offered by the Ahmedabad Municipal Transport Service (AMTS), five were chosen for analysis. These routes were effectively

graded from best to worst by the created AHP-based evaluation approach, which provided an organised and impartial evaluation of their operational performance. [3]

To examine the effects of the new bus transit system in the VISSIM environment, traffic quality metrics including average speed, delay, congestion, trip duration, and travel cost were modeled. [4]

The investigations conducted over the past 15 years to access and analyze Bengaluru's transportation sustainability are presented in this document. According to a 2003–04 research conducted for the Bengaluru Metro Rail Project's Detailed Project Report (DPR), the number of vehicles overall is growing at a pace of 10% annually, while the number of two-wheelers alone is growing at a rate of 17% annually. According to the report, the city requires a mass transit system to meet the demands of its growing working population. One finding of this study is that low occupancy vehicles, or two-wheelers, make up the bulk of the traffic composition on Bengaluru highways. The Bangalore Mobility Indicators 2010–11 study, which was prepared by Urban Mass Transit Company Limited and delivered to the Directorate of Urban Land Transport (DULT), reiterates this observation. [5]

The general objective of this work is to increase spatial efficiency by presenting a technique for the spatial assessment of transport modes. The first part of Section 2 describes how the suggested evaluation framework incorporates findings from earlier transport spatial assessment research. This section presents the comprehensive approach that was created to assess space for both parking and moving traffic. Section 4 presents measures for various means of transportation for each of the growth scenarios of Rajkot. Measures of spatial efficiency are further demonstrated for a road segment of one kilometer. The last part contains suggestions for enhancing the technique and findings. [6]

The most popular form of transportation is the bus. They have a vast network of lines and operate on the streets. Some cities have improved them by implementing bus preference signals and dedicated bus lanes. There are three types of urban transportation: mass transit, private, and for-hire. Systems of public transportation are covered in this chapter. The right-of-way (ROW) category,

technology, and operational characteristics of transit modes characterize them. There are three types of ROWs: C: mixed-traffic urban roadways. The majority of street transit options are buses, however there are also trolleybuses and tramways/streetcars. B: Tracks or lanes that are partially divided, typically seen in street medians. Compared to street transportation, semirapid transit, which mostly uses 20 ROW B, is more expensive and performs better. It consists of semirapid buses and Light Rail Transit (LRT). Metro systems and fast transit modes are made up of A-paths that are only utilized by transit vehicles. The most efficient type of urban transportation is offered by its electric rail cars, which are driven in trains. [7]

The study was conducted in Iran. In the midst of the COVID Tehran, which has a busy public transit system and heavy traffic, is where the data was gathered. 500 questionnaires were issued to Tehran residents for this purpose; 396 of them were returned, and 38 were excluded from analysis because of their incomplete responses [57–58, 60]. A total of 358 questionnaires were examined. It was discovered that 31% of participants were female and 69% of participants were male. It was discovered that 34% of interviewees were in the 20–30 age range, 31% were in the 31–40 age range, 26% were in the 41–50 age range, and 9% were in the 50+ age range. [8]

Researchers frequently combine qualitative and quantitative methods from different disciplines in this way. Quantitative data can be quantified or recorded. Qualitative data are interpretive, descriptive, and linguistically connected. Information like how many, how much, or how frequently something occurs is provided by quantitative data. Conversely, qualitative data may help us understand the causes, events, and processes of activities. Every strategy offers a number of benefits and drawbacks. The purpose of this study is to examine and contrast the advantages and disadvantages of the various language testing and assessment methodologies. These benefits included the capacity to study test-takers' behavior, perceptions, attitudes, and comprehension as well as the chance to get more knowledge regarding the creation, administration, and interpretation of assessments and tests. The results of the study demonstrated that the time needed to collect data using quantitative research techniques is significantly

shorter than that needed to collect data using qualitative research methods. [9]

The aforementioned models were created using a trial procedure that was dependent on the software's input settings. In each organized table, the software's output for every model attempt was examined and debated individually. Here, the five models must be completed, and the best model for city work visits must be chosen. Following the selection of the most suitable model, the model will be validated using the designated parameters. The optimized table derived from all models is shown below. [10]

Even though many physical barriers inside fixed-route systems have been removed, there are still numerous major obstacles to public transit systems' general accessibility. The current study set out to fully describe the obstacles that people with impairments face while utilizing public transportation and the supplemental paratransit services. 4,161 people answered an online survey that was created and distributed to contacts of the National Network of ADA Centers. The findings point to important obstacles for those with disabilities using complementing paratransit services and public transportation. It is advised to make changes to the physical environment and provide educational opportunities to lessen unfavorable attitudes toward people with disabilities since these transportation systems face both physical and attitudinal barriers. [11]

To learn more about the variables influencing the adoption of the smart shuttle in the development of sustainable transportation, a qualitative study based on the structured literature review was carried out. This study gives businesses insight into the processes involved in putting smart transport and logistics solutions into practice, which might help them create a long-lasting business network. There are two reasons this study is important. It begins by outlining the existing state of affairs with the deployment of autonomous vehicles on public roadways. Second, this study develops a new business environment and sheds light on a hitherto undiscovered set of influencing elements that contribute to sustainability. Using inter-organizational network models, a quantitative research may be carried out to create a business model for the car-sharing system. [12]

As a result, it is crucial in low-income nations with little financial means. The significance of public transit in the context of Dhaka, Bangladesh, was also noted in earlier research and analyses pertaining to transportation. [13]

scholarly domains related to road transport. The number of research examining the potential applications of intelligent transport systems (ITS) and their contribution to road safety in various nations has significantly increased in recent years. However, the number of comprehensive quantitative and qualitative studies that have been published on the subject of ITS's contribution to road safety is still rather small. [14]

Reducing traffic congestion for motorised vehicles and making the most of the growing number of motorised vehicles have been the primary goals of transportation planners. Therefore, the use of motorised transportation has been discriminatorily favoured in transportation planning thus far. The For passenger transportation systems, there are three types of space usages: journey space, parking space, and a larger ecological space that includes the area needed for transportation infrastructure and the forest land needed to absorb CO_2 emissions from urban transportation. [15]

A city's shape significantly affects how its citizens live. Careful planning is necessary when urban centres expand to prevent negative effects on the local standard of living. Planning for mobility is a crucial strategic factor. A revived interest in public transit has resulted from concerns about the sustainability of scattered, car-dependent urban structures. This essay looks at public transit accessibility and explores ways to make it better. We'll illustrate with examples from Australia's South East Queensland area. [16]
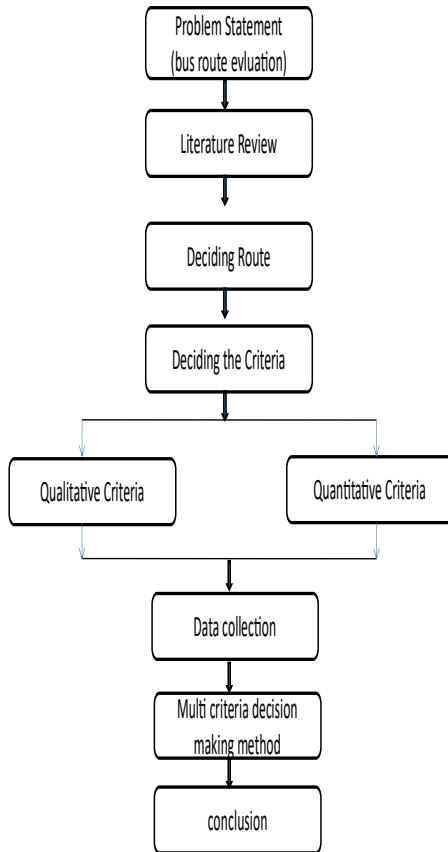
III. OBJECTIVE OF STUDY

- To evaluate the social and economical characteristics of bus commuters.
- To evaluate the different factor affects the urban bus transport.

IV. SCOPE OF THE STUDY

- Out of 50 Routes 5 route are selected for the study in Rajkot City.
- Study is limited to RMTS

V. METHODOLOGY

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Problem Statement
(bus route evluation)
       ↓
Literature Review
       ↓
Deciding Route
       ↓
Deciding the Criteria
       ↓
Qualitative Criteria    Quantitative Criteria
       ↓
Data collection
       ↓
Multi criteria decision
making method
       ↓
conclusion
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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. 1: Trikon baug to Saurashtra university; Route No. 8 : Mavdi gam to Greenland x road; Route No. 14: Huseni chowk (kothariya) to Navagam; Route No. 18: Aaji dam to Gidc gate 3; and Route No. 28: Gujarat housing board to Jivraj park.

VII. THE METHOD OF DATA ANALYSIS

1. Analytic Hierarchy Process (AHP) [3]
➤ 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 [3]
➤ 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 1: Quality Assessment of Every Route Number

Route no.	Safety	Comfort	Road condition
1	Excellent	Excellent	Good
8	Excellent	Very Good	Good
14	Excellent	Very Good	Very Good
28	Excellent	Very Good	Good
18	Excellent	Excellent	Good

2) Quantitative Evaluation and Calculation for Every Path [3]
1. The on time performance = ((2*17)+(5*35)+(10*33)+(15*3)+(20*12)/(17+35+33+3+12)
2. The cost of fuel:
1. Assume 6 km/kg of fuel efficiency.
2. Assume that the fuel cost is 80.49 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

5. Average journey speed is calculated as (Total travel distance (km)) / (Average travel time (hr.))

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 2: Quantitative Evaluation of All Route

Route no	1	2	3	4	5	6
1	8.84	14.24	378.94	0.44	16	28
8	12.79	14.15	454.83	0.38	16.26	33
14	10.41	14.13	442.10	0.44	15.27	40
28	10.99	13.92	603.63	0.32	16.75	43
18	6.96	14.26	425	0.77	19.27	35

IX. SELECTING THE BEST ROUTES WITH AHP
X.

1. All Routes Are Ranked

Table 3 : All Routes Are Ranked

Name of the route	Priority value	Ranking
University	0.109	1
Green land	0.081	4
Nava gam	0.091	3
Jivaraj park	0.070	5
G.I.D.C gate 3	0.102	2

XI. CONCLUSION

1. According to the study is socioeconomics analyzed, the majority of passengers travel daily for work and educational trip.

2. It also reveal that maximum passengers has their own house and own vehicles. It means that after having their own vehicles still they are preferred to use public transportation.

3. As our consistency ratio value came very less it means our judgments is very much nearness to perfection.

4. Given that the average user is between the ages

of 21 and 30 and the average trip length is between 12 and 17 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 14.

5. Our judgments are extremely closed to perfection because our consistency ratio value was very low.

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