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Impact of HDBRTS on Road Congestion, Safety, and Environment

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ABSTRACT

Rapid urbanisation and rising motorisation have intensified challenges related to road congestion, traffic safety, and environmental degradation in medium-sized Indian cities. In this context, Bus Rapid Transit Systems (BRTS) are increasingly promoted as cost-effective and sustainable urban transport solutions. This paper evaluates the impact of the Hubballi–Dharwad Bus Rapid Transit System (HDBRTS), Karnataka's first BRT initiative, on road congestion, road safety, environmental outcomes, and travel behaviour in the twin cities. The study adopts a mixed-method approach, drawing on primary survey data from 2,064 commuters, twenty-one focus group discussions, stakeholder interviews, and secondary data including traffic accident records for the period 2015–2023. The findings indicate that HDBRTS has contributed significantly to reducing perceived road congestion and private vehicle dependence, with nearly half of the respondents reporting a decline in personal vehicle usage. High levels of user satisfaction, travel time savings, comfort, and cleanliness have encouraged a notable modal shift towards public transport. Environmental assessment reveals that a large majority of commuters perceive HDBRTS as environmentally sustainable, with reported reductions or normalisation of air pollution levels along the corridor. Road safety analysis shows a general decline in total accidents after system implementation, although fatal accidents remain a concern, highlighting the need for stronger enforcement and behavioural interventions. Overall, the study demonstrates that HDBRTS performs strongly on key Bus Rapid Transit performance indicators such as congestion reduction, modal shift, environmental sustainability, and user satisfaction, while showing moderate outcomes in safety improvement. The findings suggest that HDBRTS represents a viable and replicable public transport model for medium-sized Indian cities, provided complementary measures related to enforcement, last-mile connectivity, and integrated mobility planning are strengthened.

Keywords: *Hubballi–Dharwad BRTS; Road Congestion; Road Safety; Environmental Sustainability; Modal Shift; Urban Mobility*

INTRODUCTION

Understanding the effectiveness of any new programme, scheme, or public intervention requires a systematic assessment of its outcomes and impacts. Impact evaluation plays a crucial role in determining whether an initiative has achieved its intended objectives, produced measurable benefits, and performed better than pre-existing alternatives. Such evaluations are particularly valuable for planners and policymakers, as they provide evidence-based insights that support corrective measures, policy refinement, and future planning. Moreover, impact assessments

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enhance transparency and accountability by demonstrating to stakeholders—including the public, funding agencies, and decision-makers—that resources are being utilised efficiently and outcomes are tangible.

In the context of urban transport systems, impact assessment assumes greater significance due to the complex challenges posed by rapid urbanisation, increasing motorisation, congestion, road safety concerns, and environmental degradation. Bus Rapid Transit Systems (BRTS) have emerged globally as a cost-effective, high-capacity public transport solution capable of addressing these challenges. Several cities across the world, including Hubballi–Dharwad in India, have adopted the BRTS model with the objective of improving mobility, reducing congestion, enhancing safety, and promoting environmentally sustainable transport.

The implementation of the Hubballi–Dharwad Bus Rapid Transit System (HDBRTS) represents a major intervention in the urban transport landscape of the twin cities. Assessing its impact is essential to understand how effectively the system has influenced travel behaviour, traffic conditions, safety outcomes, and environmental performance. An impact assessment of HDBRTS also helps identify operational strengths, existing gaps, and areas requiring further improvement, including infrastructure adequacy, service quality, public perception, and institutional effectiveness.

Further, such an assessment provides insights into the future potential of the system, including scope for expansion, replication in other medium-sized cities, and integration with broader urban mobility strategies. In this context, the present paper examines the impact of HDBRTS with specific reference to road congestion, road safety, environmental outcomes, and changes in travel behaviour. Using primary field survey data and secondary sources, the paper analyses commuter perceptions, usage patterns, accident trends, environmental impacts, and overall system performance. The analysis is organised into thematic sections covering traffic congestion, road safety, environmental impact, modal shift, and an overall assessment of HDBRTS against key Bus Rapid Transit performance indicators.

REVIEW OF LITERATURE

A substantial body of literature has examined Bus Rapid Transit Systems (BRTS) from multiple perspectives, including system performance, congestion management, road safety, environmental sustainability, user perceptions, and broader urban impacts. These studies, conducted across Indian and international contexts, provide important insights into the conditions under which BRT systems succeed or face limitations.

BRTS Performance and Operational Effectiveness: Several studies focus on the operational and design aspects of BRT systems. Research on Ahmedabad BRTS highlights the role of intelligent transport systems and automated monitoring in improving operational efficiency and reducing accident risks (Arolkar et al., 2012). Simulation-based studies from Guangzhou demonstrate that pedestrian movement, station layout, and bottleneck management significantly influence safety and evacuation efficiency at BRT stations (Wang et al., 2013). Accessibility to BRT stations has also been examined in Indian cities. Patel et al. (2015) show that most commuters prefer walking distances of about 200 metres or walking times of five minutes to reach BRT stations, emphasising the importance of station spacing and last-mile planning. In contrast, poorly planned systems—such as the Visakhapatnam BRTS—illustrate how low service frequency, unoccupied BRT lanes, roadside encroachments, and inadequate pedestrian facilities can negatively affect overall traffic performance (Babu & Naidu, 2017). Comparative studies of Bogotá's TransMilenio and Ahmedabad BRTS suggest that BRT systems can be inclusive and accessible to elderly persons and persons with disabilities when supported by appropriate infrastructure and technology (Tripathy et al., 2017). These studies collectively demonstrate that BRT performance depends not merely on infrastructure provision but on enforcement, institutional coordination, and service planning.

Congestion Reduction and Modal Shift: A large strand of literature examines the role of BRTS in mitigating congestion and encouraging modal shift away from private vehicles. Studies covering multiple Indian cities—including Ahmedabad, Pune, Indore, Surat, Rajkot, and Bhopal—argue that inefficient public transport systems have exacerbated congestion, pollution, and accidents, thereby increasing the relevance of BRTS as a sustainable alternative (Pal et al., 2018). Evidence from Indore BRTS shows that travel time savings, comfort, safety, and

convenience are the strongest determinants of BRT usage, while fare levels play a relatively smaller role (Sharma & Goliya, 2018). International studies from Pakistan and Canada further indicate that commuters are willing to shift modes when BRT offers reliable and time-efficient services, although preferences between BRT and rail-based systems vary by income and age groups (Kepaptsoglou et al., 2020; Andrew et al., 2022). However, several studies caution that inadequate feeder systems and weak land-use integration can constrain sustained modal shift. Research from Ahmedabad highlights that existing feeder services often fail to meet commuter needs and that electric rickshaws may serve as effective last-mile solutions (Trivedi et al., 2020).

Road Safety and Traffic Management: Road safety is a recurring concern in BRT literature. Road safety audits conducted on BRT corridors in Pune and other Indian cities indicate that dedicated lanes and controlled station access can reduce accident risks when supported by proper design and management (Jadhav et al., 2007; Bhojane & Jain, 2016). Nevertheless, several studies report that infrastructure improvements alone are insufficient to ensure safety. Persistent issues such as lane encroachment, speeding, signal violations, and weak enforcement continue to contribute to serious accidents, including fatalities (Babu & Naidu, 2017). These findings underscore the need for continuous safety audits, strict enforcement, and behavioural interventions to realise the full safety potential of BRT corridors.

Environmental Sustainability and Emissions: Environmental impacts constitute an important dimension of BRT evaluation. Studies from Jakarta, Ahmedabad, and Surat demonstrate that BRT systems can reduce air pollution by inducing modal shift from private vehicles and improving traffic flow efficiency (Nugroho et al., 2010; Balya et al., 2016). Declines in pollutants such as PM_{10}, NOx, and CO have been observed near BRT corridors, particularly where reductions in two-wheeler and car usage are significant. However, the literature also highlights limitations. Continued reliance on motorcycles, diesel vehicles, and inadequate feeder integration can dilute environmental gains. Recent studies advocate the adoption of low-carbon buses, promotion of non-motorised transport, and better corridor landscaping to strengthen the environmental benefits of BRT systems (Joshi & Shah, 2018; Imam, 2020).

User Perceptions and Satisfaction: User perception studies consistently report high satisfaction with BRT services, especially with respect to travel time, comfort, cleanliness, and safety. Surveys from Indore and Ahmedabad show that even when BRT fares are higher than conventional buses, users continue to prefer BRT due to superior service quality (Sharma & Goliya, 2018). Emerging research also examines non-user and workforce perspectives. Studies from Iran reveal that driver mental health and job satisfaction are influenced by factors such as passenger behaviour, scheduling, and vehicle conditions, which in turn affect system performance (Samerei et al., 2021). Research from China further demonstrates that user-perceived levels of service vary across multiple dimensions, reinforcing the importance of aligning operational standards with passenger expectations (Huo et al., 2022).

Urban and Spatial Impacts: Beyond transport outcomes, BRT systems have been shown to influence urban form and land values. Evidence from Bogotá suggests that BRT infrastructure can increase land values in low-income neighbourhoods by improving accessibility, although effects vary across income groups (Guzman et al., 2021). Integration with bicycle sharing systems and non-motorised transport has also been found to enhance mobility and environmental outcomes in cities such as Surat (Shah et al., 2016).

Despite extensive national and international literature on BRT systems, most studies focus on large metropolitan cities or internationally prominent cases. There is limited empirical evidence from medium-sized Indian cities, particularly studies that simultaneously examine congestion, safety, environmental outcomes, and behavioural change using primary data. Moreover, workforce conditions and institutional coordination remain under-explored.

The Hubballi–Dharwad Bus Rapid Transit System (HDBRTS), operational since 2018, represents Karnataka's first BRT initiative and offers a critical opportunity to address these gaps. A comprehensive, multi-dimensional evaluation of HDBRTS is therefore essential to assess its effectiveness and its potential for replication in other medium-sized cities.

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The study aims to evaluate the overall impact of the Hubballi–Dharwad Bus Rapid Transit System (HDBRTS) on urban mobility in the twin cities by examining changes in road congestion, private vehicle usage, road safety outcomes, and environmental performance. It seeks to analyse modal shift patterns across socio-economic groups, assess trends in traffic accidents and commuter perceptions of safety, evaluate perceived changes in air pollution and travel efficiency, and examine user satisfaction with service quality attributes such as comfort, cleanliness, reliability, and affordability. The study also assesses the performance of HDBRTS against key Bus Rapid Transit indicators and explores its potential for replication in other medium-sized cities.

METHODOLOGY

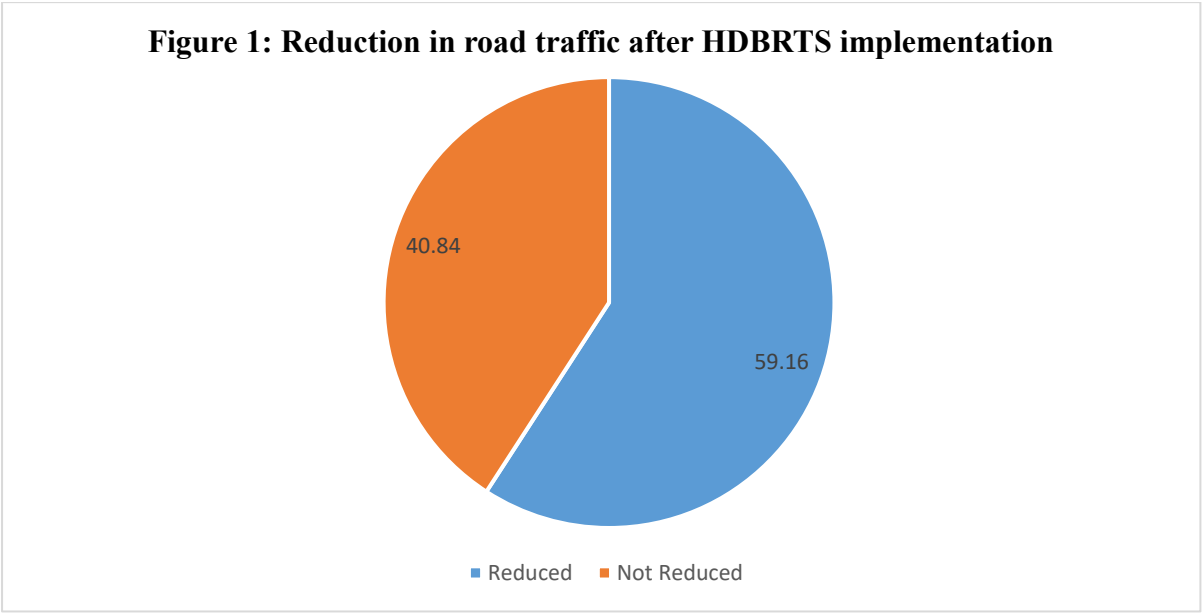
This study adopts a mixed-method research design to evaluate the impact of the Hubballi–Dharwad Bus Rapid Transit System (HDBRTS) on road congestion, safety, environmental outcomes, and travel behaviour. Primary data were collected through a structured commuter survey administered to 2,064 respondents, representing approximately three per cent of average daily ridership. A cluster sampling approach was used by grouping the 34 BRT stations into six spatial clusters along the corridor, with proportional sampling from each cluster to ensure geographic and socio-economic representation. In addition, twenty-one Focus Group Discussions were conducted with diverse user groups, including students, salaried workers, women, elderly commuters, informal workers, and persons with disabilities, along with interviews with drivers and Point-of-Sale operators to capture operational perspectives. Secondary data were obtained from official sources, including traffic accident records from the Police Traffic Section and operational reports of HDBRTS Company Limited.

Quantitative data were analysed using descriptive and inferential statistical techniques such as percentages, chi-square tests, correlation analysis, and simple regression models to examine relationships between commuter characteristics and key outcomes, including modal shift, congestion perception, safety, and environmental impact. Road safety outcomes were assessed through longitudinal analysis of accident data for the period 2015–2023 along the BRT corridor. Qualitative data from focus group discussions and interviews were analysed thematically to contextualise survey findings and identify behavioural, enforcement, and institutional issues. Methodological triangulation across data sources was employed to enhance the robustness and validity of the results.

Traffic Congestion Before and After HDBRTS

Traffic congestion represents a major challenge in rapidly urbanising corridors such as Hubballi–Dharwad, where increasing vehicle ownership and heterogeneous traffic conditions have traditionally resulted in delays, higher fuel consumption, and environmental stress. One of the primary objectives of introducing the Hubballi–Dharwad Bus Rapid Transit System (HDBRTS) was to alleviate congestion by offering a high-capacity, reliable public transport alternative and by reducing reliance on private vehicles. This section analyses commuters' perceptions of changes in road congestion and patterns of private vehicle use following the implementation of HDBRTS, thereby assessing the system's effectiveness in easing traffic pressure along the corridor.

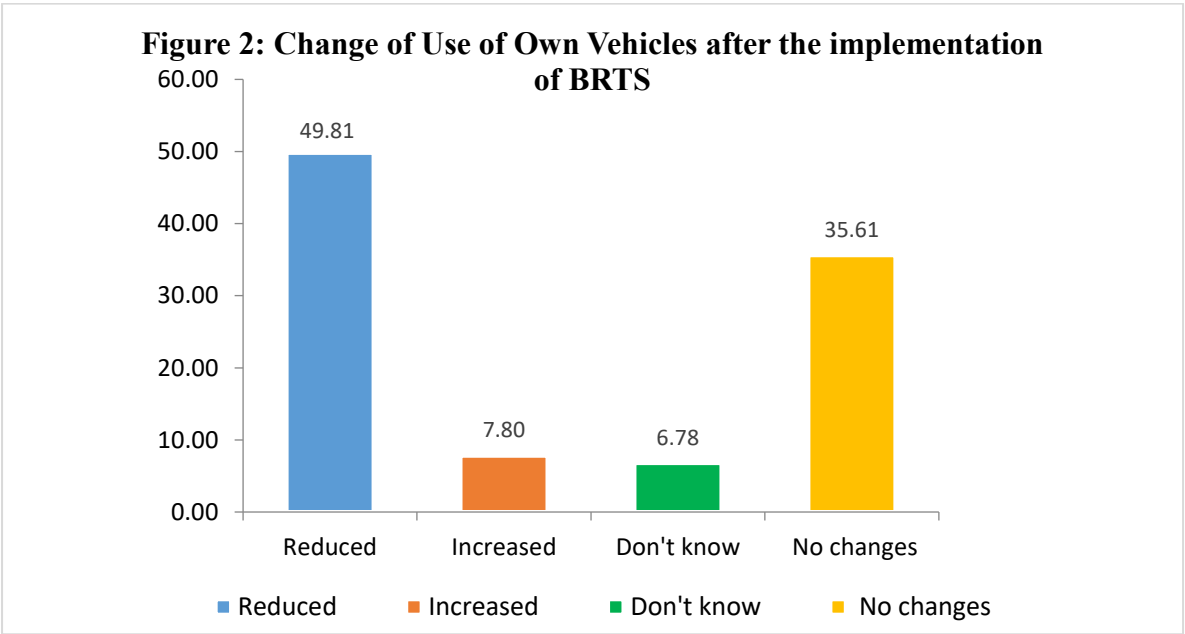
Figure 1: Reduction in road traffic after HDBRTS implementation



Source: Field survey

Figure 1 illustrates commuters' perceptions regarding changes in road traffic congestion after the introduction of the Hubballi–Dharwad Bus Rapid Transit System (HDBRTS). The results show that a majority of respondents (59.16 per cent) perceived a reduction in road traffic congestion following the implementation of HDBRTS, while 40.84 per cent felt that the system had not led to a significant reduction in congestion. Overall, these perceptions indicate that, for a substantial proportion of commuters, HDBRTS has contributed positively to improving traffic conditions along the Hubballi–Dharwad corridor by shifting passengers from mixed traffic to a dedicated public transport system.

Figure 2: Change of Use of Own Vehicles after the implementation of BRTS



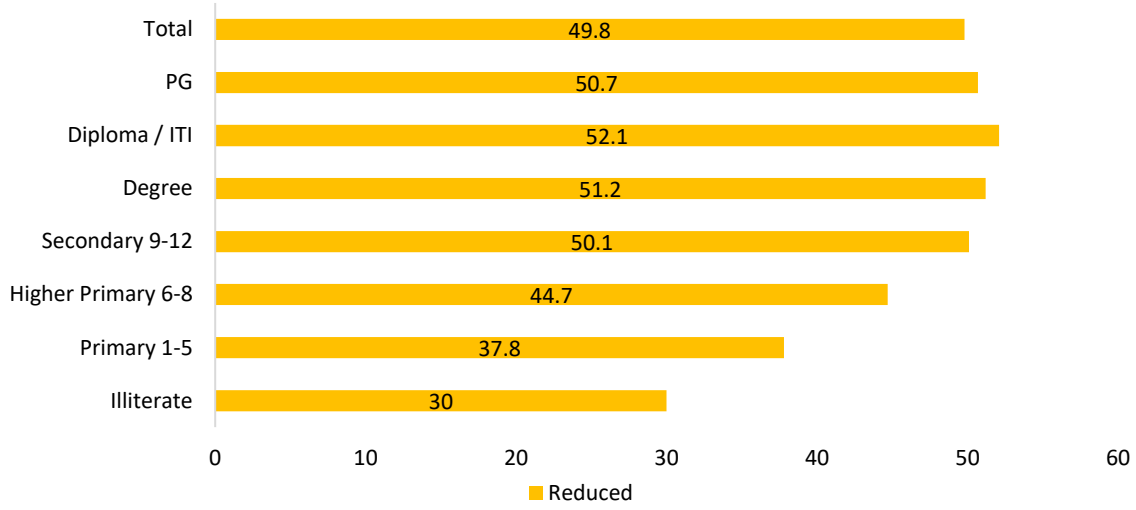
Source: Field survey

Figure 2 presents changes in the use of personal vehicles following the introduction of HDBRTS. Nearly half of the respondents (49.81 per cent) reported a reduction in their use of personal vehicles such as two-wheelers and cars. In contrast, only a small share (7.80 per cent) reported an increase in personal vehicle usage, while 35.61 per cent indicated no change and 6.78 per cent were uncertain. Overall, the evidence suggests that the implementation of

HDBRTS has contributed to a meaningful decline in private vehicle dependence among a significant section of commuters, thereby supporting congestion reduction and promoting more sustainable urban mobility.

The introduction of HDBRTS is likely to have reduced the use of personal vehicles such as two-wheelers and cars, given the frequent availability and reliability of BRTS services at commuters' preferred travel times. Figure 3 depicts the extent of reduction in personal vehicle use across different educational levels. The results indicate that the reduction is more pronounced among respondents with higher educational attainment.

Figure 3: Reduction of Use of Own Vehicles after the Implementation of BRTS among education Level

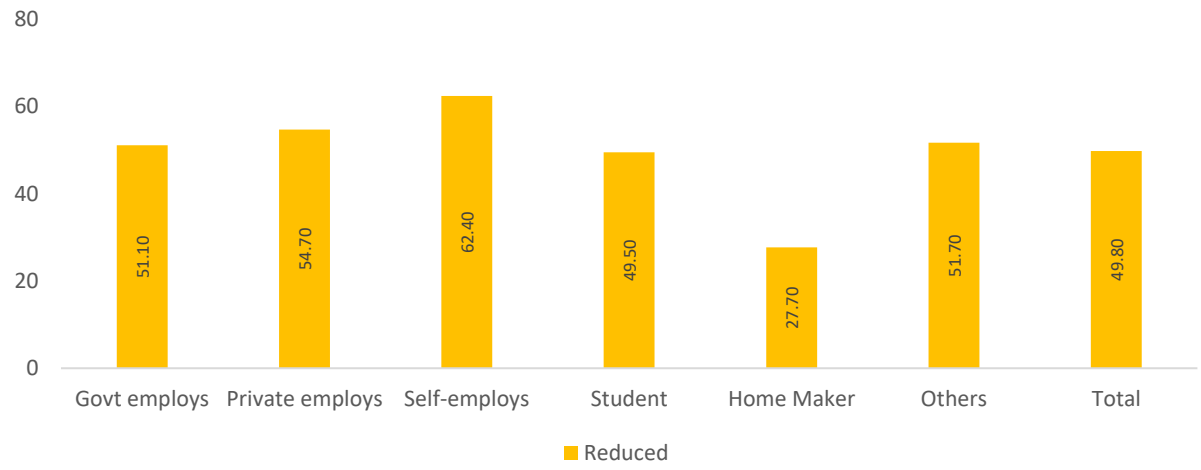


Source: Field Survey

The highest levels of reduction are observed among diploma/ITI holders (52.1 per cent), degree holders (51.2 per cent), and postgraduates (50.7 per cent). This pattern suggests that higher levels of education may be associated with greater awareness of, and willingness to adopt, alternative and sustainable transport modes. Notably, even among illiterate and primary-educated respondents, reductions of 30.0 per cent and 37.8 per cent, respectively, were reported, indicating a broader behavioural shift across socio-educational groups. These findings highlight the role of education in shaping transport choices and have important implications for sustainable urban mobility planning and the wider adoption of BRTS.

Figure 4 illustrates the reduction in personal vehicle usage across different occupational groups following the introduction of the Bus Rapid Transit System. Entrepreneurs and self-employed professionals exhibit the highest reduction rate (62.4 per cent), suggesting a strong preference for BRTS as an alternative mode of transportation. Private sector employees also demonstrate a substantial reduction (54.7 per cent), followed by government employees (51.1 per cent), indicating a positive response across formal employment sectors. Students report a moderate reduction of 49.5 per cent, while homemakers show a comparatively lower reduction rate (27.7 per cent). Respondents classified under "Others" report a reduction of 51.7 per cent. Overall, nearly half of the respondents (49.8 per cent) across occupational categories reduced their use of personal vehicles. These patterns highlight the effectiveness of HDBRTS in encouraging a modal shift away from private vehicles, with important implications for traffic decongestion, environmental sustainability, and the promotion of inclusive and sustainable transport options.

Figure 4: Reduction of Use of Own Vehicles after the Implementation of BRTS among different occupations



Source: Field Survey

Road Accident Patterns and Safety Perceptions

Safety constitutes a critical dimension of urban mobility systems, particularly in rapidly growing cities where congestion, mixed traffic conditions, and weak enforcement mechanisms often heighten risks for commuters. The Hubballi–Dharwad Bus Rapid Transit System (HDBRTS) was designed not only to improve mobility but also to enhance road safety through the provision of dedicated corridors, regulated station access, and reduced interaction between buses and mixed traffic. This section examines available accident data to assess whether these intended safety benefits have materialised along the key BRTS corridor.

Table 1: Road Accidents (2015-2023): Jubilee Circle to Hosur Cross Route, Dharwad to Hubballi

Sl. No	Year	Total Accidents		
		Fatal	Non-Fatal	Total
1	2015	26	126	152
2	2016	18	88	106
3	2017	15	66	81
4	2018	16	68	84
5	2019	19	99	118
6	2020	34	72	106
7	2021	34	82	116
8	2022	20	103	123
9	2023 up to February	5	23	28

Source: Police Traffic Section, Hubballi-Dharwad

Road Safety Trends Along the BRTS Corridor

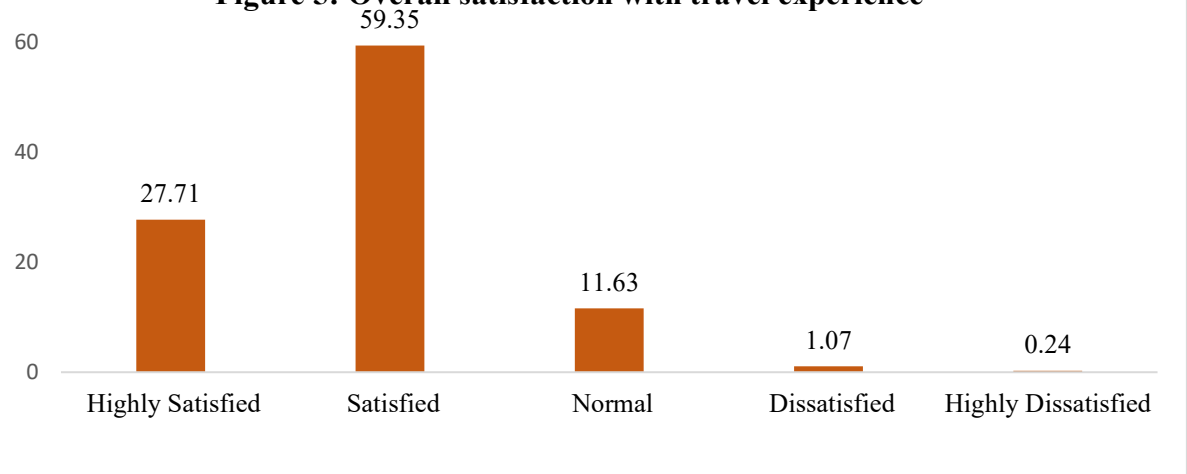
Table 1 presents accident data along the Jubilee Circle–Hosur Cross corridor for the period 2015 to 2023. The data reveal considerable year-to-year fluctuations in both fatal and non-fatal accidents. Total accidents declined sharply from 152 in 2015 to 81 in 2017, followed by an increase to 118 in 2019. During the pandemic year (2020), while overall traffic volumes declined, the number of fatal accidents increased, a trend that continued into 2021. Data for 2023 are available only up to February, which limits a comprehensive assessment for the year.

Although the long-term trend suggests a reduction in the total number of accidents along the corridor following the introduction of HDBRTS, a critical concern emerges from the data: fatal accidents did not decline proportionately and, in some years (2020–2021), reached their highest recorded levels. This divergence between declining total accidents and persistently high fatal accidents indicates that the safety benefits of improved road infrastructure have been partially offset by behavioural and enforcement-related factors.

The continued occurrence of fatal accidents points to persistent non-compliance with traffic regulations, including encroachment into BRT lanes, over-speeding in mixed traffic, and disregard for traffic signals. This finding is consistent with broader evidence from Indian cities, where infrastructure improvements alone have not always translated into safer road outcomes without parallel enhancements in enforcement, road-user awareness, and behavioural change.

Passenger perceptions regarding safety and overall travel experience on HDBRTS further reinforce the system's performance outcomes. The survey results indicate that more than one-fourth of the respondents (27.71 per cent) reported being highly satisfied with their travel experience, while a substantial majority (59.35 per cent) expressed satisfaction. A smaller proportion of respondents (11.63 per cent) described their experience as neutral. Dissatisfaction levels were minimal, with only 1.07 per cent reporting dissatisfaction and a negligible 0.24 per cent expressing high dissatisfaction. Overall, these findings clearly indicate that an overwhelming majority of commuters perceive HDBRTS as a safe and satisfactory mode of transport. High satisfaction levels suggest that, despite concerns related to accident severity along the corridor, users largely view the system as reliable, secure, and comfortable for daily travel.

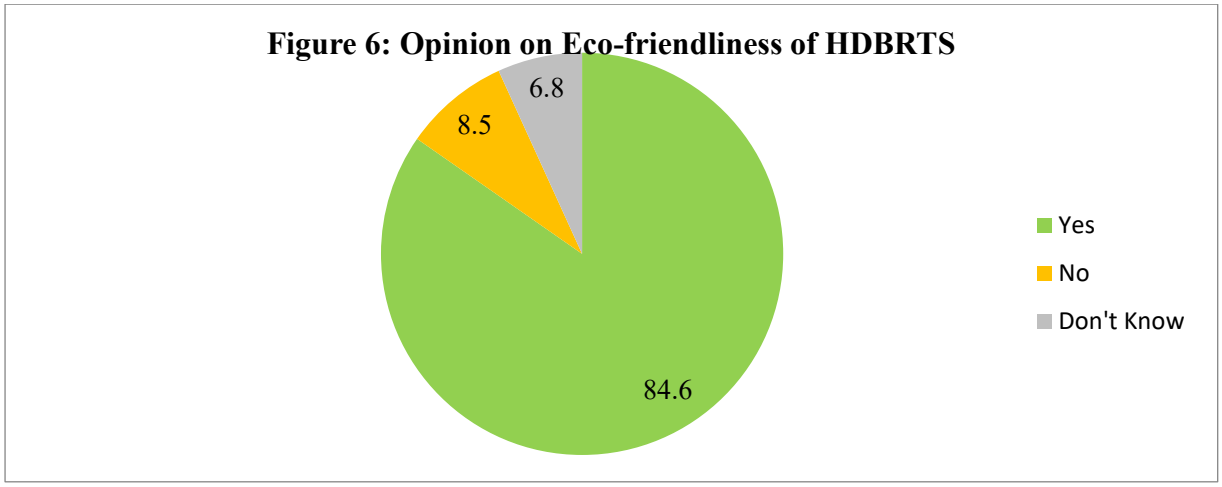
Figure 5: Overall satisfaction with travel experience



Source: Field survey

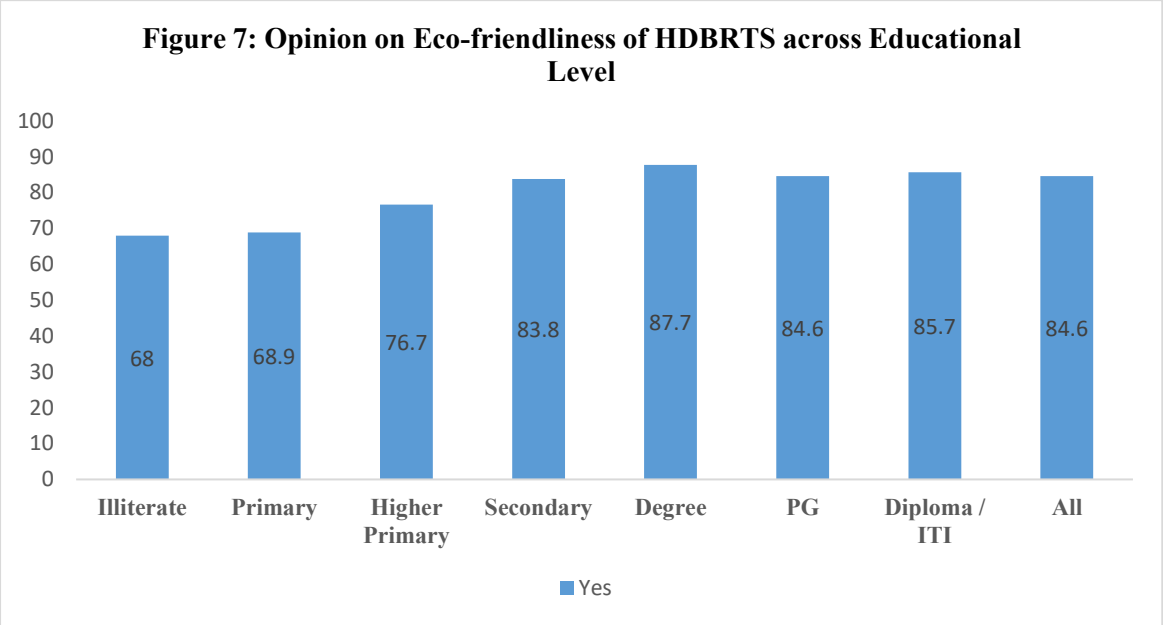
Environmental Impact: Air Quality, Vehicle Use, and Emissions

The opinions of the respondents regarding the environmental sustainability of HDBRTS are shown in Figure 6. According to the data presented in the Figure , a significant majority of the respondents (84.6%) expressed the belief that HDBRTS is environmentally friendly. Conversely, a minority of participants (8.5%) indicated that HDBRTS is not environmentally friendly. Ultimately, 6.8 percent of respondents indicated that they were uncertain about the eco-friendliness of HDBRTS. The data suggests that a significant proportion of the participants held the belief that HDBRTS is environmentally friendly.



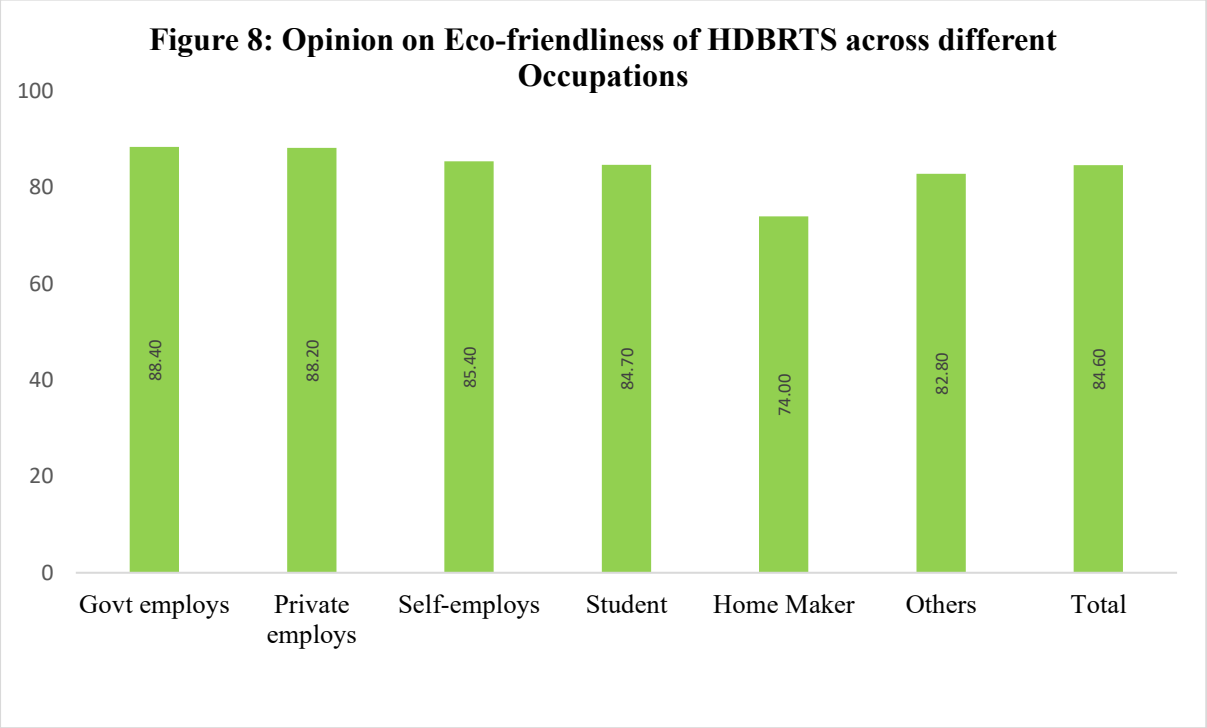
Source: Field survey

Corridors that are highly structured and dedicated to HDBRTS as well as Green lane through the BRTS lane



Source: Field survey

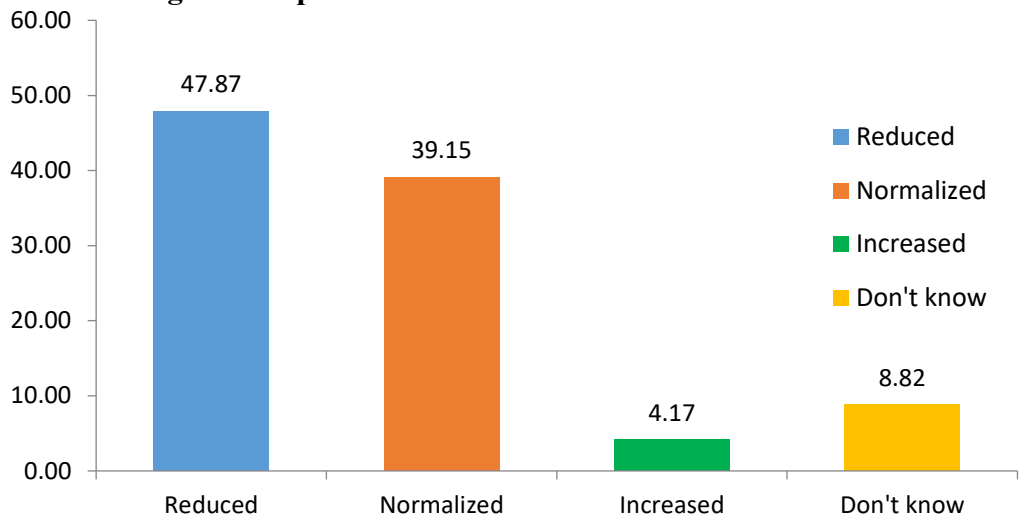
The data presented in Figure 7 demonstrates a distinct and positive correlation between the level of education achieved and the perceived environmental friendliness of HDBRTS. As individuals' educational attainment progresses from illiteracy to postgraduate degrees, there is a steady and substantial rise in the proportion of survey participants who confirm the environmentally sustainable nature of HDBRTS. Significantly, individuals holding a degree and advanced academic credentials exhibit notably elevated levels of endorsement, with percentages of 87.7 per cent and 84.6 per cent, respectively.



Source: Field Survey

Figure 8 illustrates the viewpoints of individuals from different professions regarding the environmental sustainability of HDBRST. A thorough analysis reveals that a substantial majority (88.40%) of Government Employees have indicated their confidence in the environmental sustainability of the HDBRTS. The Private Employees (88.20%), Self-employed individuals (85.40%), Students (84.70%), Other individuals (82.80%), and Home Makers (74.00%) are the groups that closely follow.

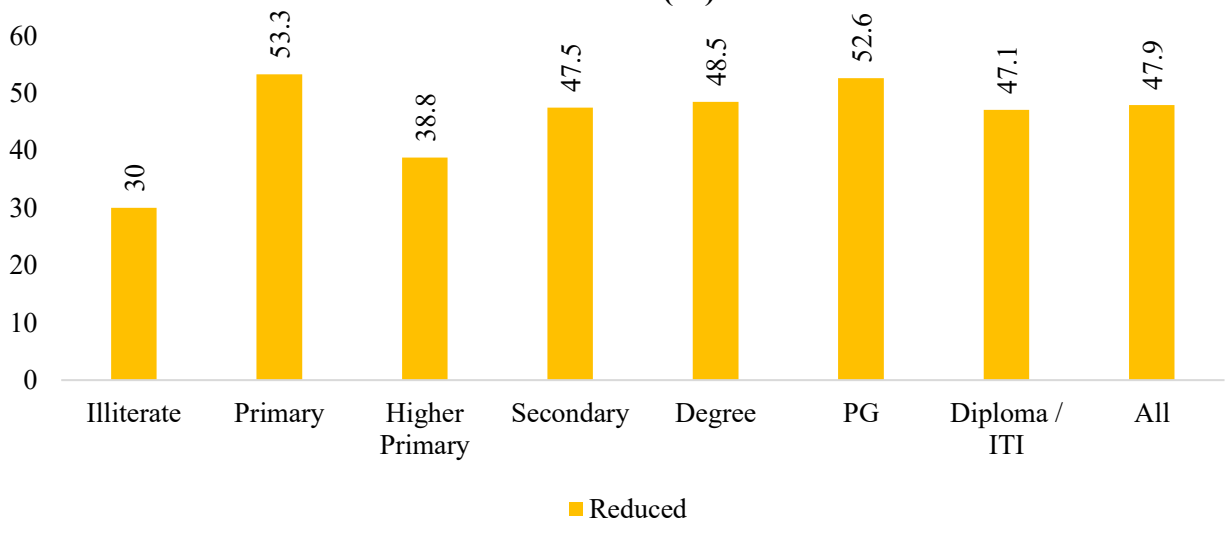
Figure 9: Opinion on Air Pollution after the BRTS



Source: Field survey

Figure 9 provides data on the air pollution resulting from the HDBRTS. The data indicates that 47.87 percent of respondents believed that it effectively reduced air pollution, 39.15 percent believed that it had a neutral impact on air pollution, 4.17 percent expressed that it actually contributed to air pollution, while 8.87 percent expressed that they were unaware of its impact. The data suggests that the introduction of the HDBRTS led to a reduction in air pollution.

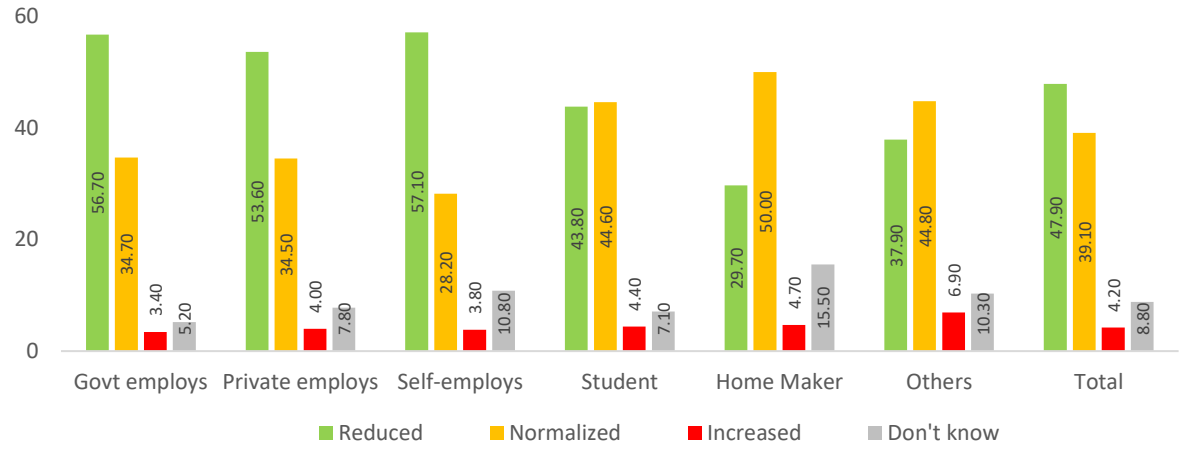
Figure 10: Educational Status of Respondents by their Opinion on Air Pollution (%)



Source: Field survey

The air pollution due to heavy traffic between Dharwad and Hubli was also another issue for discussion. An effort has been made to examine the impact of BRTS bus on air pollution. The data provided in Figure 10 indicate that about 48 per cent of travellers reported that the air pollution declined after the introduction of BRTS buses which are air pollution free vehicles. The air pollution was also declined due to decline in the total number of busses which were used to ply before the BRTS buses. Such opinion was reported to be more perceptible among the traveller with better educational status as compared to their counterparts. About 40 per cent of commuter said that after introduction of BRTS bus the air pollution was normalized. It was felt to be more among the travellers of better educational background than those of lower ones. It can be noted that very little percentage of travellers reported that the air pollution increased after the introduction of BRTS bus. It is evident that the introduction of BRTS bus has reduced and normalized the air pollution due to heavy traffic and more number of vehicles plying between Dharwad and Hubli.

Figure 11: Occupation Wise of Respondents by their Opinion on Air Pollution (%)



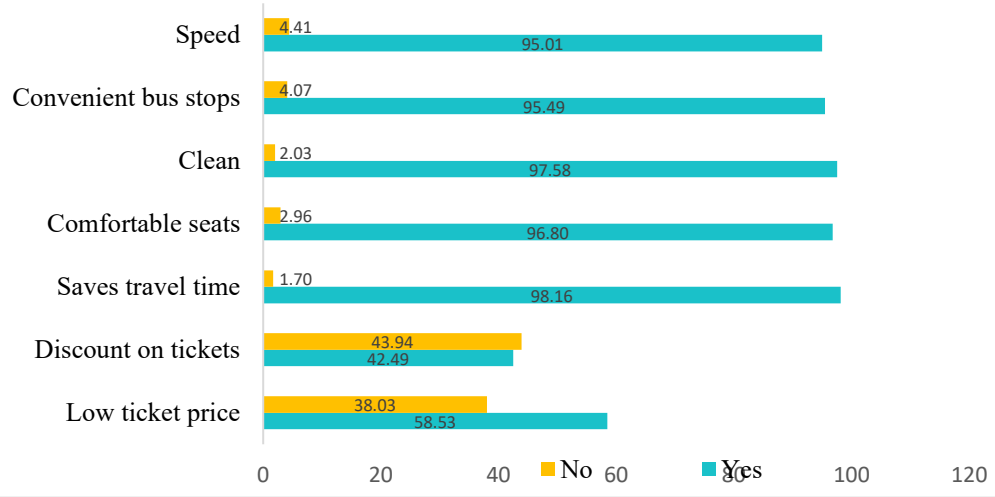
Source: Field Survey

The above Figure 11 indicates the commuter's observation about how is the air pollution caused by HDBRTS buses. In total 47.90 per cent commuters said reduced, 39.10 per cent normalised and 4.20 per cent said increased. In occupation wise 57.10 per cent self employs said reduced and 50.00 per cent home makers said normalised.

Changes in Modal Shift

The advantages of HDBRTS in comparison to alternative modes of transport in the cities of Hubballi and Dharwad are detailed in Figure 12. Compared to other modes of transportation, the data indicates that it is advantageous in the following respects: time efficiency (98.16%), affordability of tickets (58.53%), comfort of seats (96.80%), cleanliness (97.58%), proximity to bus stops (95.49%), and speed (95.01%). However, in comparison to alternative modes of transportation, it exhibits a subpar performance in terms of ticket discounts, offering only 42.49 percent.

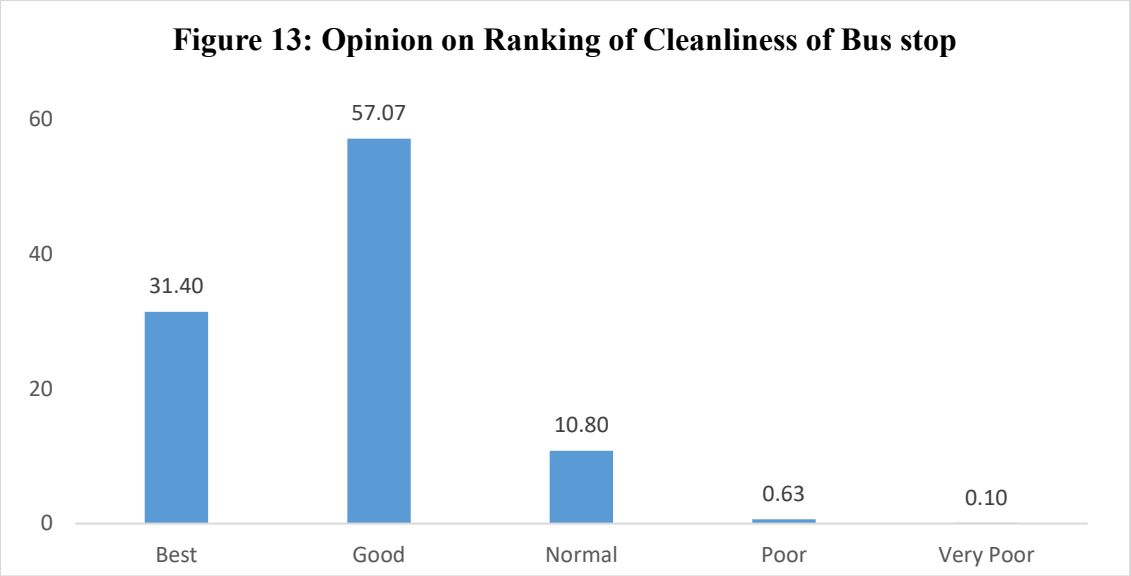
Figure 12: Opinion on Good Aspects of HDBRTS Compared to Other Modes of Transport



Source: Field survey

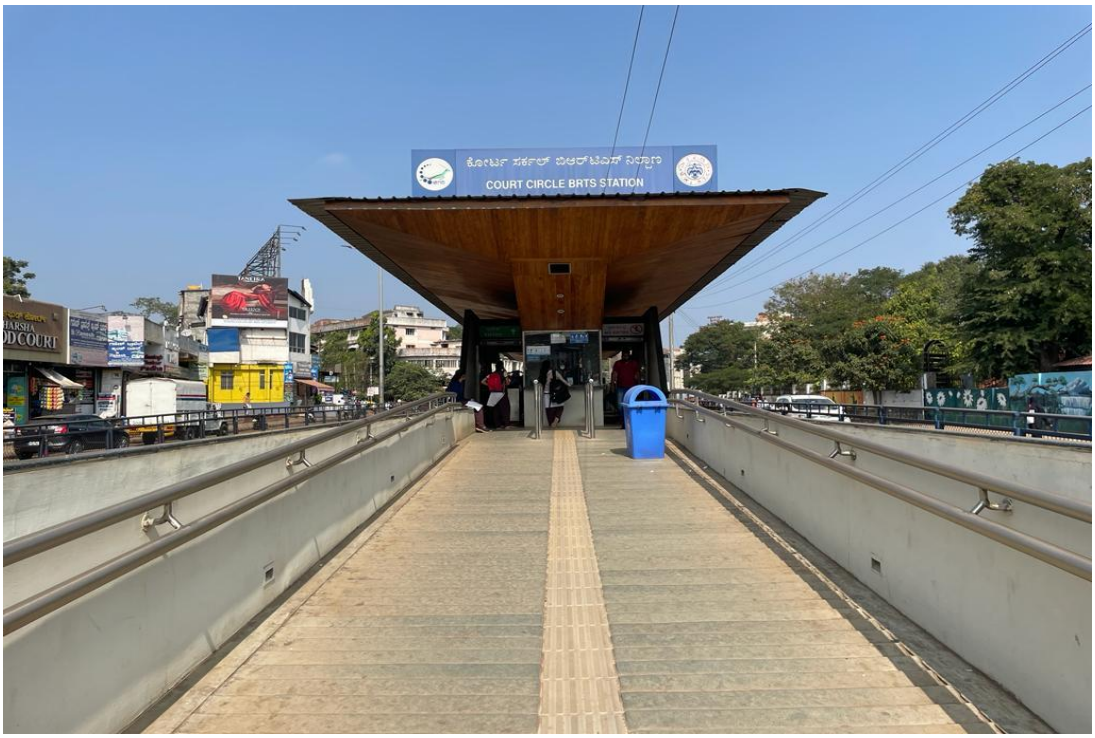
HDBRTS Bus Stop and Inside Bus Cleanliness:

In order to uphold cleanliness in HDBRTS, the management has likely implemented a range of measures such as frequent cleaning and sanitization of the buses, which includes disinfecting the seats, floors, and other surfaces that passengers may touch. Installing waste receptacles within the bus terminal and in proximity to bus stations to promote responsible disposal of refuse by passengers. Implementing regular pest control protocols to proactively deter the presence of insects and rodents. To promote hand hygiene during the pandemic, BRTS has provided hand sanitizers or hand-washing facilities at bus stands.



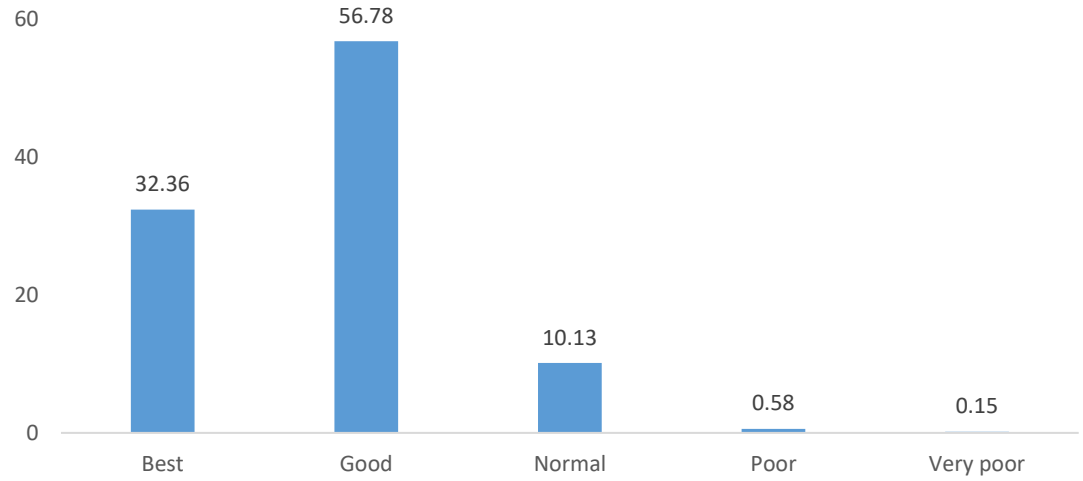
Source: Field survey

Figure 13 provides data on the cleanliness of the HDBRTS bus stops. The data illustrates that 31.40 percent of travellers consider the cleanliness to be excellent, 57.07 percent of travellers perceive it as good, 10.80 percent find it to be average, while 0.63 percent regard it as poor and 0.10 percent of passengers deem it as very poor. According to the data, travellers have reported that the HDBRTS bus stops are clean.



The HDBRTS bus stops are well organized, clean, and designed to be convenient for Commuters

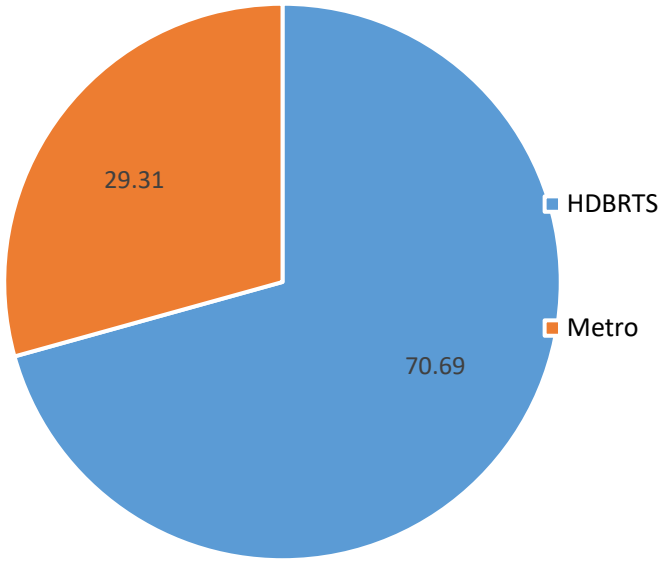
Figure 14: Distribution of Respondents Opinion on cleanliness of Inside bus



Source: Field survey

Detailed information regarding the cleanliness of the interior of the HDBRTS buses is presented in Figure 14. There were 32.36 percent of travellers who thought it was the best, 56.78 percent who thought it was good, 10.13 percent who thought it was normal, 0.58 percent who thought it was normal, and 0.15 percent who thought it was very poor. According to the Figure, the vast majority of passengers were of the opinion that the HDBRTS bus has a satisfactory level of cleanliness.

Figure 15: Opinion on BRTS vs. Metro

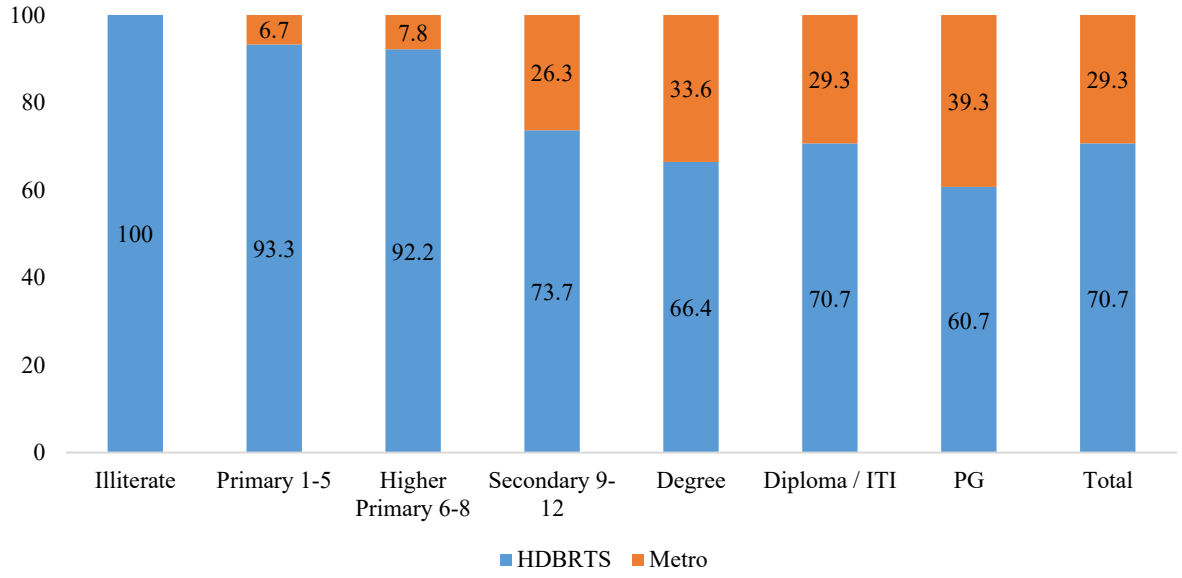


Source: Field survey

The data shows public opinion on the HDBRTS vs. metro system for Hubballi and Dharwad. HDBRTS was preferred by 70.69% of respondents, indicating a strong preference for bus rapid transit. Cost-effectiveness, flexibility, and faster implementation than a metro system may influence this preference. However, metro networks' sp, capacity, and modernity may appeal to 29.31%. The clear majority in favour of HDBRTS suggests its potential benefits in meeting city transport needs, emphasising the importance of local context and preferences in urban planning. Future

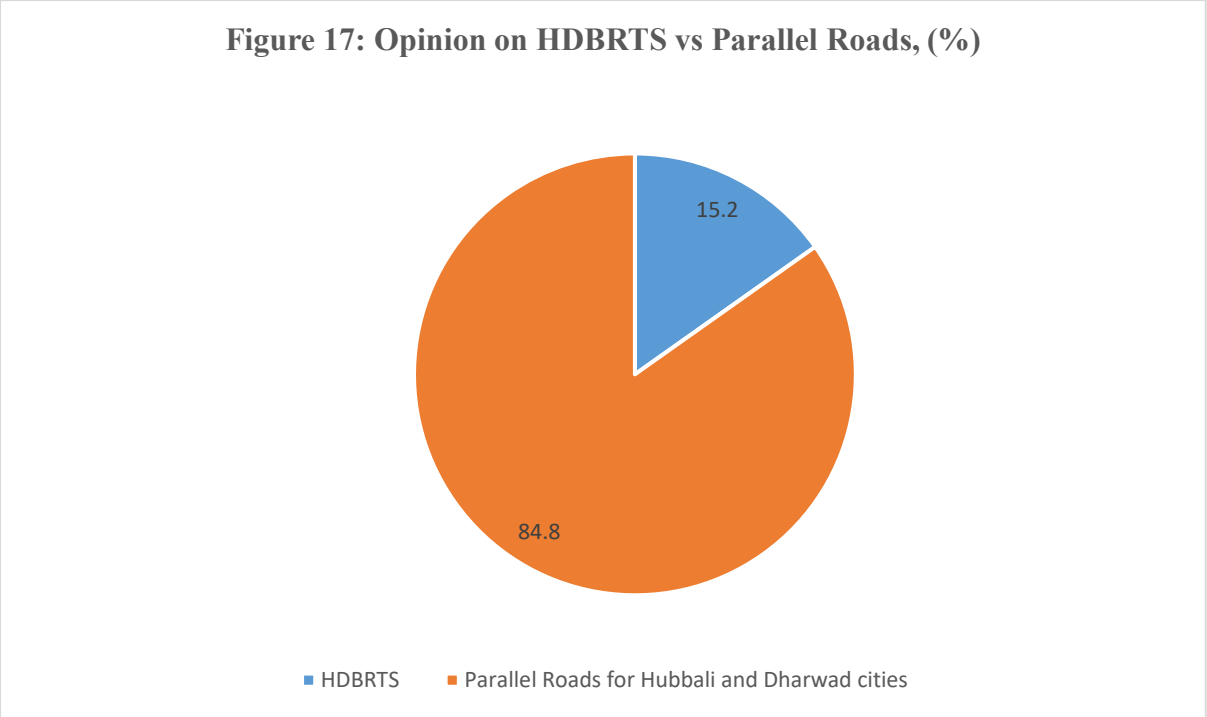
Hubballi and Dharwad transport infrastructure planning may benefit from further study of these preferences' causes (Figure 16).

Figure 16: Distribution of Respondents Reporting with their best choice between BRTS and Metro (%)



Source: Field Survey

In the public domain, there was a general debate that instead of BRTS, there should have been metro between Dharwad and Hubli on account of cost-effectiveness, traffic ease and environment benefits. The data provided in Figure 8.16 show that a great majority of travellers, accounting for 70.7 per cent, reported that they preferred BRTS bus to Metro between Dharwad and Hubli. It was reported to be quite higher among the travellers with lower educational background as compared to that of higher educational background. On the other hand, about 29.3 per cent of travellers opined that they preferred Metro to BRTS bus for their daily travel between these twin cities. It was reported to quite higher among the travellers with better educational background than that of lower ones (Figure 16).



Source: Field Survey

Public opinion on the HDBRTS and parallel roads for Hubballi and Dharwad is shown in the data. With 84.8 per cent of respondents preferring parallel roads, there is a strong preference for road infrastructure over bus rapid transit. This preference may be due to improved road networks, reduced traffic, and increased accessibility. However, 15.2 per cent prefer HDBRTS, suggesting a minority prefers a more organised and dedicated public transportation system. The majority support parallel roads, emphasising the importance of road infrastructure in urban planning for Hubballi and Dharwad and a preference for solutions that directly affect road connectivity and traffic flow. Policymakers planning future transport projects in these cities may benefit from studying these preferences' causes (Figure 17).

Assessment of HDBRTS Against Key BRT Performance Indicators

This section synthesises the empirical findings of the study to evaluate the performance of the Hubballi–Dharwad Bus Rapid Transit System (HDBRTS) against internationally recognised Bus Rapid Transit (BRT) performance indicators. The objective is to assess whether HDBRTS can be considered a successful, effective, and replicable urban transport model for medium-sized Indian cities.

Table 2: Assessment of HDBRTS Against Key Bus Rapid Transit (BRT) Performance Indicators

BRT Performance Indicator	Evidence from the Present Study	Assessment Level
Congestion Reduction	59.16% of commuters reported reduced road congestion; nearly 50% reduced use of personal vehicles after HDBRTS implementation	Strong
Safety Improvement	Decline in total accidents along the BRT corridor; high levels of perceived safety and commuter satisfaction	Moderate
Environmental Sustainability	More than 84% of respondents perceive HDBRTS as environmentally friendly; reduced air pollution reported	Strong
Modal Shift	Significant shift from personal vehicles (two-wheelers and cars) to HDBRTS across education and occupation groups	Strong

User Satisfaction	Approximately 87% of commuters reported being satisfied or highly satisfied with HDBRTS services	Very Strong
Replicability Potential	High public acceptance; preference for HDBRTS over metro due to cost-effectiveness and feasibility	Strong

Key indicators commonly employed in BRT evaluations—such as congestion reduction, safety improvement, environmental sustainability, modal shift, and user satisfaction—are examined using evidence generated from the primary field survey and secondary data analysis. Table 4.2 presents a consolidated assessment of HDBRTS performance across these indicators.

SUMMARY AND FINDINGS

This paper examined the impact of the Hubballi–Dharwad Bus Rapid Transit System (HDBRTS) on road congestion, safety, environmental outcomes, and travel behaviour, using primary field survey data and secondary sources. The analysis provides clear evidence that HDBRTS has generated substantial positive impacts across multiple dimensions of urban mobility.

With respect to traffic congestion, the findings indicate that HDBRTS has contributed meaningfully to easing congestion along the Hubballi–Dharwad corridor. A majority of commuters perceived a reduction in traffic congestion, supported by a notable decline in the use of personal vehicles. Reductions in private vehicle use were observed across educational and occupational groups, suggesting a broad behavioural shift rather than one confined to specific social categories.

In terms of road safety, the analysis reveals mixed outcomes. While total accidents along the BRT corridor show a general declining trend over time, fatal accidents have not reduced proportionately and remain a concern in certain years. This indicates that infrastructure improvements alone are insufficient to ensure road safety without complementary measures related to enforcement, compliance, and user behaviour. Despite this, commuter satisfaction levels regarding safety and overall travel experience remain high, reflecting strong user confidence in the system.

Environmental impact assessment shows that HDBRTS is widely perceived as environmentally sustainable. A large majority of respondents consider the system eco-friendly, and many reported reductions or normalisation of air pollution levels after its introduction. These perceptions were particularly strong among respondents with higher educational attainment and across most occupational groups, reinforcing the role of HDBRTS in promoting cleaner urban transport.

The analysis of modal shift demonstrates that HDBRTS performs favourably when compared with alternative transport modes in terms of time efficiency, comfort, cleanliness, accessibility, and speed. High levels of satisfaction with station and onboard cleanliness further enhance the system's attractiveness. Public preference data also indicate strong support for HDBRTS over a metro system, largely due to cost-effectiveness and feasibility, although a majority still expressed preference for parallel road development, highlighting the continued importance of road infrastructure in urban planning.

Overall, the findings establish HDBRTS as a high-performing public transport intervention that has positively influenced mobility patterns, reduced dependence on private vehicles, and contributed to environmental sustainability, while also revealing areas requiring policy attention, particularly in road safety enforcement.

SUGGESTIONS

Based on the empirical findings of this paper, the following policy-oriented and operational suggestions are proposed to enhance the effectiveness, safety, and long-term sustainability of HDBRTS.

First, stronger enforcement of traffic regulations along the BRT corridor is essential. While infrastructure quality has improved, persistent fatal accidents indicate the need for stricter monitoring of lane discipline, speed regulation, and signal compliance. Enhanced coordination between traffic police and HDBRTS authorities, supported by automated surveillance systems, can significantly improve safety outcomes.

Second, behavioural and awareness-based interventions should complement enforcement measures. Targeted road safety campaigns focusing on two-wheeler riders, pedestrians, and private vehicle users can improve compliance and reduce risky behaviour near BRT corridors and intersections.

Third, continued efforts to discourage private vehicle use should be strengthened through service enhancements rather than restrictive measures alone. Improving service frequency during peak hours, ensuring reliable last-mile connectivity, and integrating feeder services can further consolidate the shift towards public transport.

Fourth, environmental benefits of HDBRTS can be amplified by gradually transitioning towards cleaner bus technologies, improving green landscaping along corridors, and strengthening emissions monitoring. Public communication strategies highlighting environmental gains can further reinforce positive perceptions and encourage sustainable travel choices.

Fifth, cleanliness and service quality—key strengths of HDBRTS—should be maintained through regular audits, user feedback mechanisms, and institutional accountability. Sustaining high service standards is crucial for retaining existing users and attracting new riders.

Finally, given the strong public acceptance and cost-effectiveness of HDBRTS, future urban transport planning in Hubballi–Dharwad should prioritise integrated mobility solutions. Rather than viewing BRTS, metro, and road infrastructure as competing alternatives, planners should adopt a complementary approach that balances public transport expansion with necessary road improvements.

CONCLUSION

The impact assessment presented in this paper demonstrates that the Hubballi–Dharwad Bus Rapid Transit System has emerged as a successful urban transport intervention with significant positive outcomes. HDBRTS has contributed to reducing traffic congestion, encouraging a shift away from private vehicles, improving travel efficiency, and promoting environmentally sustainable mobility. High levels of user satisfaction further affirm the system's acceptance and operational effectiveness.

At the same time, the persistence of fatal accidents along the corridor highlights the limitations of infrastructure-led solutions in the absence of strong enforcement and behavioural change. Addressing these challenges is critical to realising the full safety potential of the system.

When evaluated against key Bus Rapid Transit performance indicators, HDBRTS performs strongly across congestion reduction, environmental sustainability, modal shift, and user satisfaction, with moderate performance in safety improvement. These findings suggest that HDBRTS represents a viable, scalable, and replicable model for medium-sized Indian cities seeking cost-effective alternatives to capital-intensive metro systems.

In conclusion, HDBRTS stands as an important example of how well-planned Bus Rapid Transit systems can contribute to balanced urban development, sustainable mobility, and improved quality of life. With targeted policy refinements and continued institutional support, the system has the potential to deliver even greater long-term benefits for the Hubballi–Dharwad region and beyond.

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