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Metropolitan Public Transport Lines in Tirana: Assessment of Public Mobility.

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Abstract

Public transportation systems play a crucial role in providing residents with accessible transportation options in urban areas, and buses serve as the primary mode of public transportation in the Tirana Metropolitan Area due to various factors such as infrastructure limitations and urban planning challenges. This study utilises multi-criteria analysis (MCA) to evaluate 25 bus lines within the Tirana Metropolitan Area, aiming to assess their institutional impact, environmental footprint, and socioeconomic effects. The research seeks to provide insights into how these bus routes contribute to environmental sustainability, community well-being, and institutional compliance while aligning with the Sustainable Development Goals (SDGs). A comparative analysis with Vienna's public transportation system, renowned for its advanced network, highlights the challenges faced by Tirana in achieving a sustainable and efficient mobility system. Geographic mapping of public transportation stations and lines in Tirana reveals discrepancies in coverage, accessibility, and effectiveness across municipalities. Through MCA, the study systematically assesses key indicators to identify the strengths and weaknesses of each bus line. Results indicate that "The Green Line" emerges as the top-performing public transport line with a rating of 9.4, while "Qyteti Studenti" is identified as the least effective line with a rating of 3.2.

Keywords:
Public Transport System, Multi-Criteria Analysis (MCA), Tirana Metropolitan Area, Public Transport Evaluation.

Introduction

Public mobility systems represent crucial infrastructure and services that provide public transportation opportunities for citizens within urban areas. This encompasses various modes of public transportation such as buses, trains, metros, trams, public bicycles, and other services facilitating intra-city movement.

In the case of the Tirana metropolitan area, this mobility is primarily provided through buses. The reasons for this may be complex and linked to various factors including:

1. Lack of infrastructure for other services: Tirana inherits a predominantly old city infrastructure, making it challenging to intervene and offer new infrastructure such as constructed lines for trains, metros, or trams.
2. Investments and urban planning: Developing public transport lines, especially metros and trams, requires significant investments and carefully planned urban strategies.
3. Current needs and capacity: In certain instances, bus services may be more adaptable to immediate needs and the capacity of people's movement within a city.

1.1 Aim of the research
The aim of the research is to conduct a comprehensive analysis of the 25 bus lines within the

Tirana Metropolitan area. The primary focus is on using Multi-Criteria Analysis (MCA) to evaluate the performance of each bus line based on three critical dimensions: socio-economic impact, environmental impact, and institutional impact. The research aims to provide a nuanced understanding of how these bus lines contribute to community well-being, environmental sustainability, and their alignment with institutional frameworks, as well as their compatibility with Sustainable Development Goals (SDGs). By using MCA, the study aims to create a systematic and objective approach, enabling a thorough examination of the strengths and weaknesses of each bus line, contributing valuable insights for the improvement and optimization of the public transport system in the Tirana Metropolitan area.

1.2 Research Questions
• How does the socio-economic impact of the 25 bus lines contribute to access and economic activities in the Tirana metropolitan area?
• What is the environmental footprint of each bus line and how does it align with sustainable practices?
• How do institutional frameworks regulating the 25 bus lines affect their operational efficiency and overall effectiveness in providing public transport services?
• In what ways do the analysed bus lines address or contribute to social equality and inclusion?
• How does the reliability and frequency of each bus line affect the daily travel experiences of residents and visitors?
• To what extent do the 25 bus lines contribute to reducing traffic congestion and promoting a more sustainable urban transport system?
• What are the challenges and opportunities associated with integrating institutional policies to enhance the efficiency and effectiveness of public transport services?
• How do bus lines address the diverse needs of the population in terms of accessibility, affordability, and comfort?

1.3 Objectives
• Assessment of socio-economic impact
• Analysis of environmental footprint
• Examination of social equality and inclusion
• Evaluation of travel experiences
• Identification of challenges and opportunities
• Assessment of alignment with Sustainable Development Goals (SDGs)

Literature Review
Public transportation is a critical aspect of urban life, influencing the accessibility, efficiency, and sustainability of a city; therefore, many countries prioritize it. Let's take the case of the Vienna metropolitan area, known for its advanced and integrated transport network, located alongside the Tirana metropolitan area, which faces challenges in creating comprehensive public mobility.

Vienna is renowned for its highly efficient public transport infrastructure, setting high standards for metropolitan transport systems. The city's public transport network is seamlessly integrated, offering an efficient combination of buses, trams, metro lines, and passenger trains. Operated by Wiener Linien, the public transport company, Vienna's system is known for its reliability, punctuality, and extensive coverage, effectively connecting the city and its suburbs. The U-Bahn, Vienna's metro system, plays a key role in providing fast and convenient transport within the city. Supplemented by an extensive tram and bus network, Vienna's residents and visitors benefit from a

well-organized and comprehensive public mobility system. The city places a strong emphasis on sustainability, evident in its promotion of cycling through dedicated lanes and bike-sharing programs, contributing to a holistic and environmentally friendly transport ecosystem.

On the other hand, the Tirana metropolis, while in the process of developing its public mobility system, faces evident challenges. The city relies mainly on buses, minibuses, and taxis, forming the backbone of its public transport. Efforts are being made to improve the system, with initiatives such as the introduction of bike-sharing programs and the creation of pedestrian-friendly areas. However, the metropolitan area is facing issues such as traffic congestion, limited coverage of public transport, and the lack of a well-established system.

Evolution of the Mobility System in Tirana: Transformations, Challenges, and Institutional Responsibilities

Historically, the mobility system in Tirana has undergone numerous transformations and developments, including changes in infrastructure, public transportation services, and shifts in private car usage. Key historical moments that can be mentioned include:

1. Pre-1990 period: Tirana, being a relatively small city during this period, relied primarily on buses and taxis for public transportation, with private car usage being restricted.
2. Post-1990s: Following the fall of the communist regime in Albania, significant changes and developments occurred in Tirana's infrastructure and transportation system. As the economy opened up, private car ownership became permissible, introducing new challenges related to traffic and infrastructure.
3. Recent developments: In recent years, local authorities and the government have taken steps to improve the mobility system, including enhancing road infrastructure, adding bicycle lanes (primarily in the Tirana municipality), investing in public transportation, and efforts to reduce traffic congestion and environmental pollution through the addition of green lines.
In terms of institutional responsibilities, several institutions and bodies are involved in managing the infrastructure and transportation system in the Tirana metropolitan area:

1. Municipality of Tirana, Vora, & Kamza: The Municipality holds primary responsibility for managing road infrastructure and certain aspects of public transportation and urban planning in the city.
2. Ministry of Transport and Infrastructure: The Ministry oversees transport policies and strategies at the national level and may play a role in financing and supporting infrastructure projects in Tirana, Vora & Kamëz.
3. Public Transport Operators: Public transport companies are responsible for providing public transportation services and managing bus fleets.

Aligning Tirana's Metropolitan Public Transport with Sustainable Development Goals

The Sustainable Development Goals (SDGs) are a group of 17 global objectives adopted by all United Nations Member States in 2015 as part of the 2030 Agenda for Sustainable Development. These aims provide a common plan for peace and prosperity, addressing global challenges such as poverty, inequality, climate change, environmental degradation, peace, and justice.

In the analysis below, alignment with the SDGs can provide a robust framework, considering how Tirana's public transport system contributes to or challenges specific SDGs, such as:

		Socio-Economic impact						Environmental impact	
		Conformity assessment			Assessment of service coverage			Environmental assessment	
	Lines	N.of seats	Safety tools	Velocity (+ v urb)	Frequency index	N.o of seats	Time spent at the station	Fuel efficiency (km/l) for 1 hour	Eco-friendly technology
Tirana Municipality	1 A Allias - Selitë	29	yes	40	every 30min	21	8	30/10	No
	1 B Allias - Kodra e Diellit 2	29	yes	40	every 30min	24	8	30/10	No
	2 Teg - Kopështi Zoologjik - Ish Stacioni i Trenit	42	yes	40	every 20min	6	8	30/10	No
	3A Astir	35	yes	40	every 30min	30	8	5/1.6	Yes
	3B Kashar	35	yes	40	every 30min	21	8	5/1.6	Yes
	4 Qendër-City Park	21	yes	40	every 20min	24	8	30/10	No
	5A Ish-Uzina Autotraktorëve	35	yes	40	every 10min	15	5	30/10	No
	5B Instituti	35	yes	40	every 6.3 min	13	8	29/10	No
	6 Laprakë	21	yes	40	every 30min	15	8	30/10	No
	8A Qendër-TEG	35/21	yes	40	every 10min	6	8	29/10	No
	8B Qendër-Senatorium	21	yes	40	every 60min	12	8	30/10	No
	8C Qendër-Sauk i Vjetër	21	yes	40	every 60min	15	8	30/10	No
	9A Qyteti i Studentit	21	yes	40	every 60min	14	8	31/10	No
	9B Vilat Gjermane	21	yes	40	every 60min	13	8	30/10	No
	10A Materniteti i Ri-Qendër	21	yes	40	every 30min	17	5	31/10	No
	10B Qendër-Mihal Grameno	21	yes	40	every 60min	12	8	30/10	No
	10C Rrethrrotullimi Shkozë-Ish fusha e Aviacionit	21	yes	40	every 60min	15	5	30/10	No
	11 Porcelani	29	yes	40	every 10min	13	15	30/10	No
	12 Uzina Dinamo	35	yes	40	every 7min	17	8	30/10	No
	13 Tirana e Re	35	yes	40	every 7min	27	8	30/10	No
	15A Kombinat-Kinostudio	35	yes	40	every 10min	18	8	30/10	No
	15B Kombinat-Tufinë	35	yes	40	every 8.5min	9	8	33/10	No
	16 Linja e Gjelbër	35	yes	40	every 6min	18	5	5/1.6	Yes
Vora Municipality	7 Vora	33/35/21	yes	40+	every 20min	19	8	32/10	No
Kamza Municipality	14 Kamëz	35	yes	40+	every 10min	25	8	31/10	No

Table.1/ Identification and integration of weak points and strong points of 25 urban transport lines.

Objective 11 (Sustainable Cities and Communities):
– Assessing how Tirana's metropolitan public transport contributes to making the city more sustainable, accessible, and resilient.
Objective 3 (Good Health and Well-being):
– Evaluating the impact of public transport on the health and well-being of Tirana's metropolitan residents, taking into account factors such as air quality, traffic safety, and access to healthcare facilities.
Objective 13 (Climate Action):
– Assessing the sustainability of Tirana's metropolitan public transport in reducing greenhouse gas emissions and promoting environmentally friendly transport options.
Objective 10 (Reduced Inequalities):
– Analysing how the public transport system addresses or exacerbates social and economic inequalities within the Metropolis.
Objective 5 (Gender Equality):
– Examination within the field of public transport can contribute valuable insights into addressing gender inequalities in urban mobility and creating a safe environment.
Linking research to the SDGs can provide a global context for the importance of Tirana's metropolitan public transport in sustainable development and demonstrate the interconnectedness of urban planning with broader international goals.

Methods

This study aims to fully assess public transportation effectiveness within three municipalities, by applying Multi-Criteria-Analysis framework. Integrating research, and multi-criteria analysis the methodology includes three main phases: data collection, analysis and interpretation. Data collection process included gathering of all necessary information. This involved literature review as well as field data collection and direct communication with employees in this sector. In the analysis phase, geospatial techniques were used to interpret and visualize the collected data effectively. To generate the maps, data from the respective municipality's official websites and open data were used. Also, in these maps (figure 3,4,5) station points were used, and a determining radius value of 400 meters was employed for each station. The core analytical framework employed in this study is the Multi-Criteria-Analysis. These methods help to consider different factors in the process. The structure developed includes weighting, scoring, and aggregation to evaluate performance in different bus lines of public transport.

Results and Discussion

Fig.1/ Public transport stations in the municipalities: Tirana, Vora & Kamza

Based on these analyses, the most notable observation is the Municipality of Tirana, which has the highest number of stations and routes, whereas the Municipality of Vorë only has 2 stations and just 1 route enabling transport. The analyses above concern the coverage radius of public transport for all three municipalities in the metropolitan area. Regarding the evaluation of the bus lines, the worst line was Qyteti i studentit, while the best was the Greenline, both of these lines operate in the municipality of Tirana.

What stands out in the three aforementioned maps (Figures 3, 4, 5) is the public transport coverage in the Municipality of Vorë, which is entirely inadequate, clearly illustrating how a significant portion of the territory lacks proper access to that service. Similarly, in the Municipality of Kamëz, it can be observed that a considerable part of the territory lacks access to public transport.

In the case of the Municipality of Tirana, public transport coverage is good, with very few areas unable to access public transport. However, in the case of Tirana, the problem lies in the system of connecting transport routes. In Figure 2, it can be clearly seen how all routes tend to converge towards the center, the only hub enabling connections between peripheral areas (Figure 6). The trends in the territorial development of Tirana are becoming radial, but in the case of public transport, this development is not yet being reflected.

In the tables below, the evaluation and weighting of indicators for public transportation lines are presented. Regarding their evaluation, the value representing the minimum assessment is 1, and the value representing the maximum assessment is 10. These indicators were assigned a specific weight based on their importance in this assessment, and then all points were aggregated to present a final evaluation score.

The tables provided present the evaluation and weighting process of indicators based on the framework of the Multi-Criteria-Analysis. At first, indicators needed for the evaluation were determined. Table 1, showcases the evaluation of these indicators, representing the assessment of each ones performance on a scale from one to ten, where a score of 1, indicates a weak performance and a score of 10 the highest performance.

Table 2 outlines the assignment of specific weights to each indicator based on its perceived importance. After the necessary calculations, the evaluation of each public transportation line was derived. This provides a measurable basis for evaluating performance and prioritizing criteria according to their significance.
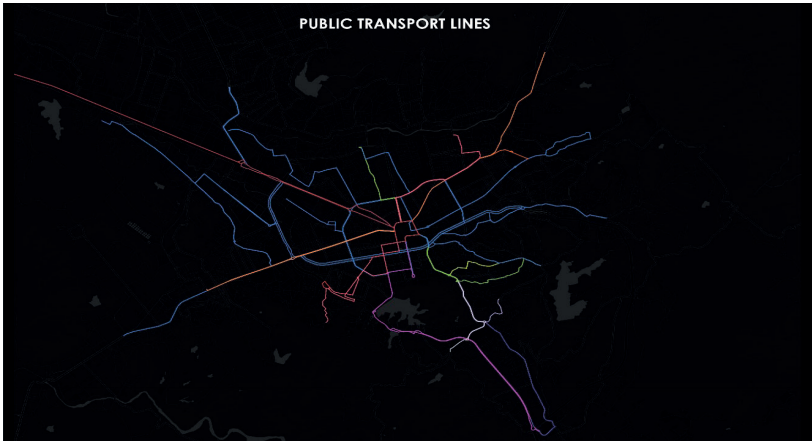
Fig.2/ Public transport ines in the municipalities: Tirana, Vora & Kamza
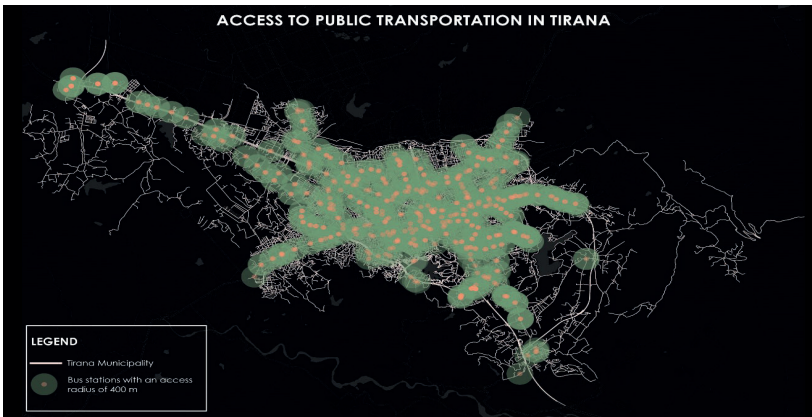

Fig.3/ The coverage radius of the public transport services in the municipality of Tirana

Fig.4/ The coverage radius of the public transport services in the municipality of Kamza
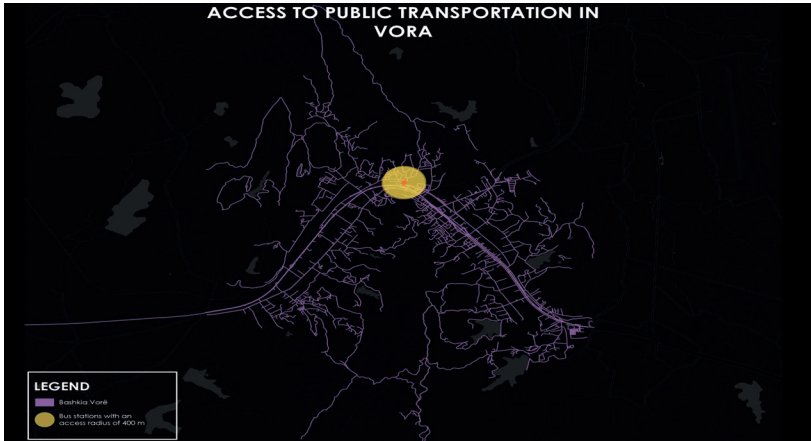
Fig.5/ *The coverage radius of the public transport services in the municipality of Vora*

Fig.6/ *The main poles where the lines meet*

Fig.7/ *Multistations, stations accessible from 2 or more lines*

		Socio-Economic impact						Environmental impact	
		Conformity assessment			Assessment of service coverage			Environmental assessment	
	Linjat	N.o of seats	Safety tools	Velocity (+ v urb)	Frequency index	N.o of seats	Time spent at the station	Fuel efficiency (km/l) for 1 hour	Eco-friendly technology
Tirana Municipality	1 A Allias - Selitë	6.9	10	10	5	7	7	2	1
	1 B Allias - Kodra e Diellit 2	6.9	10	10	5	8	7	2	1
	2 Teg - Kopështi Zoologjik - Ish Stacioni i Trenit	10	10	10	6	1	7	2	10
	3A Astir	8.3	10	10	5	10	7	10	10
	3B Kashar	8.3	10	10	5	7	7	10	1
	4 Qendër-City Park	1	10	10	6	8	7	2	1
	5A Ish-Uzina Autotraktorëve	8.3	10	10	8	5	10	2	1
	5B Instituti	8.3	10	10	10	4.3	7	2.5	1
	6 Laprakë	1	1	10	5	5	7	2	1
	8A Qendër-TEG	6.9/8.3	1	10	8	1	7	2.5	1
	8B Qendër-Senatorium	1	1	10	1	4	7	2	1
	8C Qendër-Sauk i Vjetër	1	1	10	1	5	7	2	1
	9A Qyteti i Studentit	1	1	10	1	4.6	7	1.7	1
	9B Vilar Gjermane	1	1	10	1	4.3	7	2	1
	10A Materniteti i Ri-Qendër	1	1	10	5	5.6	10	1.7	1
	10B Qendër-Mihal Grameno	1	1	10	8	4	7	2	1
	10C Rrethrrotullimi Shkozë-Ish fusha e Aviacionit	1	10	10	1	5	10	2	1
	11 Porcelani	6.9	10	10	8	4.3	1	2	1
	12 Uzina Dinamo	8.3	10	10	9.5	5.6	7	2	1
	13 Tirana e Re	8.3	10	10	9.5	9	7	2	1
	15A Kombinat-Kinostudio	8.3	10	10	8	6	7	2	1
	15B Kombinat-Tufinë	8.3	10	10	9	3	7	1	1
	16 Linja e Gjelbër	8.3	10	10	10	6	10	10	10
Vora Municipality	7 Vora	6.9/7.8/8.3	10	1	6	6.3	7	1.5	1
Kamza Municipality	14 Kamëz	8.3	10	1	8	8.3	7	1.7	1

Table. 2/ Evaluation of indicators.

		Socio-Economic impact						Environmental impact		
		Conformity assessment			Assessment of service coverage			Environmental assessment		
	Lines	N.o of seats	Safety tools	Velocity (+ v urb)	Frequency index	N.o of seats	Time spent at the station	Fuel efficiency (km/l) for 1 hour	Eco-friendly technology	
Tirana Municipality	1 A Allias - Selitë	6.9	10	10	5	7	7	2	1	6.5
	1 B Allias - Kodra e Diellit 2	6.9	10	10	5	8	7	2	1	6.6
	2 Teg - Kopështi Zoologjik - Ish Stacioni i Trenit	10	10	10	6	1	7	2	1	6.2
	3A Astir	8.3	10	10	5	10	7	10	10	8.8
	3B Kashar	8.3	10	10	5	7	7	10	10	8.5
	4 Qendër-City Park	1	10	10	6	8	7	2	1	6.3
	5A Ish-Uzina Autotraktorëve	8.3	10	10	8	5	10	2	1	7.1
	5B Instituti	8.3	10	10	10	4.3	7	2.5	1	7.1
	6 Laprakë	1	1	10	5	5	7	2	1	4.1
	8A Qendër-TEG	7.6	1	10	8	1	7	2.5	1	4.6
	8B Qendër-Senatorium	1	1	10	1	4	7	2	1	3.4
	8C Qendër-Sauk i Vjetër	1	1	10	1	5	7	2	1	4.1
	9A Qyteti i Studentit	1	1	10	1	4.6	7	1.7	1	3.2
	9B Vilar Gjermane	1	1	10	1	4.3	7	2	1	3.4
	10A Materniteti i Ri-Qendër	1	1	10	5	5.6	10	1.7	1	4.4
	10B Qendër-Mihal Grameno	1	1	10	8	4	7	2	1	4.5
	10C Rrethrrotullimi Shkozë-Ish fusha e Aviacionit	1	10	10	1	5	10	2	1	5.6
	11 Porcelani	6.9	10	10	8	4.3	1	2	1	6.1
	12 Uzina Dinamo	8.3	10	10	9.5	5.6	7	2	1	7.1
	13 Tirana e Re	8.3	10	10	9.5	9	7	2	1	7.4
	15A Kombinat-Kinostudio	8.3	10	10	8	6	7	2	1	7.5
	15B Kombinat-Tufinë	8.3	10	10	9	3	7	1	1	6.6
	16 Linja e Gjelbër	8.3	10	10	10	6	10	10	10	9.4
Vora Municipality	7 Vora	7.6	10	1	6	6.3	7	1.5	1	5.2
Kamza Municipality	14 Kamëz	8.3	10	1	8	8.3	7	1.7	1	5.7
Distribution of points according to importance		7%	20%	15%	15%	10%	10%	15%	8%	
		0.07	0.2	0.15	0.15	0.1	0.1	0.15	0.08	

Table. 3/ Weighting of indicators.

Conclusions

From the analysis conducted through mapping, the following conclusions emerged:

1. In the Tirana metropolitan area, the Municipality of Tirana has the highest number of stations, better accessibility, and more transport lines.

2. The Municipality of Vora has very low accessibility, with only 2 stations, leaving a large part of the territory without coverage from this service.

3. Despite the circular territorial development of Tirana, the public transport system continues to be monocentric, where the peripheries are connected only through central routes.

The analysis of the indicators included in the multi-Criteria Analysis allows us to make a comprehensive assessment of the aspects of the public transport system in the three mentioned municipalities. In the evaluation analysis phase, the indicators were rated from 1 to 10, with 1 corresponding to the lowest rating and 10 to the highest rating. From this phase, the following conclusions were drawn:

1. The Teg-Zoo-Former train station line has a high number of seats; however, given its low frequency, there is a risk of overcrowding, which does not justify the high rating of this indicator.

2. Most transport lines are equipped with safety measures, indicating a safe and reliable experience for citizens. However, a considerable number of lines were not equipped with these measures, raising doubts about their efficiency.

3. Regarding the speed of these buses, urban lines do not exceed an average speed of 30 km per hour. Lines such as Vora or Kamza, which are interurban lines, may exceed this speed, affecting the comfort and safety of passengers, hence these two lines have the lowest rating.

4. Five out of twenty-five analyzed lines have a frequency indicator of once every sixty minutes. This indicates that these lines have inadequate and low accessibility.

5. Lines like Center-TEG and TEG-Former train station have the lowest number of stops. This indicates that these lines have limited-service coverage and low accessibility.

6. The Porcelan line spends a very long time at the station. This leads to an unstable flow of this line, overcrowding of the bus, and low passenger comfort.

7. Three out of twenty-five bus lines have a "Hybrid" system, meaning they operate with battery power at speeds up to 25 km per hour, and after that, they switch to combined petrol and battery power, making these lines efficient. This efficiency reduces operational costs and mitigates environmental impact. The rest of the lines have a very low rating for this indicator, indicating a high level of pollution.

8. The introduction of three "Hybrid" lines indicates an effort to reduce emissions and align with sustainable transport practices.

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