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Explaining Strategies for Developing Clean Transportation in the Central Area of Cities (Case Study: District Eight of Shiraz)

Majid Tani[1], Yaghowb Peyvastehgar[2*] Mehrdad Kholghifard[3] Sayyed Yaghoub Zolfegharifar[3]

[1] PhD Student, Department of Urban Planning, Yasuj Branch, Islamic Azad University, Yasuj, Iran
[2] Associate Professor, Department of Architecture and Urban Planning, Yasuj Branch, Islamic Azad University, Yasuj, Iran
[3] Assistant Professor, Department of Civil Engineering, Yasuj Branch, Islamic Azad University, Yasuj, Iran

*** Corresponding author email address**: Peyvastehgar@gmail.com

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Abstract

The metropolises of developing countries have consistently struggled with traffic and its associated problems, leading to significant losses. Considering the importance of this issue, the present study aims to explain strategies for developing clean transportation in District Eight of Shiraz. This study employed mixed methods (descriptive-analytical and survey). In other words, data collection utilized both field methods (questionnaire completion and expert interviews) and library research. Furthermore, to achieve the research objectives, the SWOT model and the QSPM matrix were applied. The study's findings indicate that the superior strategy for developing clean transportation in District Eight of Shiraz is the ST strategy. In other words, for the development of clean transportation, the studied area should adopt a defensive (ST) strategy as its operational foundation. Regarding the development of clean transportation in the studied area, the top operational strategy priority should be providing diverse transportation plans for public use.

Keywords: *Public Monitoring, Public Policy, Crowdsourcing, Public Services.*

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1. Introduction

Urbanization is intensifying and expanding globally. Urban environments, dominated by human activity, are active ecosystems increasingly influenced by the complex interdependencies of a changing global system [1]. Urban spaces consist of various dimensions and contexts that shape urban forms. The spatial distribution of urban elements contains different layers of conceptual indicators related to society. Therefore, understanding how various urban elements influence the configuration of space is essential [2]. In this context, modern urbanism, initially considered a reform movement, has transformed into a new paradigm in urban planning and design. The promotion of modern urbanism's physical design concepts began in the 1980s with the development of residential coastal lands in Walton County, Florida. By the 1990s, the principles of planning and design, established during the first three Congresses for the New Urbanism, gained widespread popularity. These physical design principles, applicable to developments ranging from neighborhoods to transportation and streets, were developed to address urban problems and experiences of that time, distinguishing the New Urbanism movement and the projects it promoted as exceptions [3-7].

Urban planners, designers, and New Urbanism advocates viewed these projects as responses to the social and spatial segregation of populations based on income, environmental quality, the decline of public spaces, and the growth of undesirable suburban phenomena known as sprawl. On the other hand, urban planners and city officials regarded these projects as sustainable growth initiatives [7].

Rapoport defines urban space as an urban environment comprising a set of connections and interactions. Additionally, a vibrant street is described as one that hosts various individuals engaged in primarily stable and

sustainable activities, particularly those with social characteristics. Examples of social interactions and connections include a physical object, a glance, a conversation, or relationships among individuals that necessitate defining appropriate events and activities, which subsequently shape individuals' roles in the space and their membership in social groups and networks. Spaces supporting fixed activities—such as standing, sitting, talking, eating, drinking, or reading—provide opportunities for brief and limited contacts, fostering easy and relatively common interactions with others [8].

Currently, one of the most critical factors in enhancing life dynamics and facilitating all social, economic, and cultural activities within cities is urban transportation. Urban transportation directly and indirectly affects the processes and comprehensive development of cities [9]. Urban transportation is considered one of the most significant factors influencing urban structure. With the development of various urban transportation methods and significant demographic changes, this issue has become one of the most pressing problems for cities [6]. Urban transportation, as a social, political, and economic phenomenon, has consistently played a crucial role in the socio-economic structure of cities and the quality of life of their residents [5].

Despite the importance of moving goods and people in contemporary cities and substantial investments in this domain, the intensified use of motor vehicles and the growing urban population have led to extensive changes. Over recent years, developed and developing countries have sought to enhance the foundations of sustainable and clean transportation through investments and technological advancements [10].

Currently, transportation in the central areas of metropolises faces numerous challenges, such as outdated and complex roads, increased car ownership, lack of necessary standards, insufficient public transportation fleets, inadequate infrastructure, narrow roads, rising single-occupancy vehicles, limited space, insufficient safety, increased accidents, heightened pollution, social inequality in access to conventional transportation means, higher fossil fuel consumption, deteriorating urban environmental quality, unsustainable transportation systems, reduced citizen comfort, health threats, and economic losses.

Given the increasing urban pollution and its widespread implications, urban sustainability development is being pursued vigorously. Among the critical aspects of urban sustainability development is the promotion of sustainable transportation. In many countries, urban managers often organize urban transportation within an integrated management framework. They aim to enhance the sustainability of the urban transportation sector by employing new planning and design methods, skilled professionals, and effective tools [11]. In this context, adopting clean transportation requirements and fostering its development serves as one of the most important strategies for creating sustainable urban transportation systems and reducing traffic and environmental issues [12].

In advanced countries, increasing the possibilities for walking, cycling, and using renewable fuel-powered vehicles has been emphasized as a means to mitigate urban transportation system challenges and pollution [13]. Similarly, in the metropolises of developing countries, urban transportation managers aim to comprehensively monitor, control, and manage this sector to achieve sustainable improvement. Consequently, attention to clean transportation has gained prominence in most of Iran's metropolises to reduce urban traffic and pollution.

The literature on sustainable urban transportation highlights diverse factors influencing its development. Felix et al. (2019) emphasize that cities with low cycling maturity often face challenges despite growing interest in cycling, suggesting that targeted policies addressing barriers and motivations are essential [14]. Similarly, Teixeira et al. (2020) underscore the impact of the built environment, noting that cycling infrastructure can reduce stress and enhance safety, while frequent stressful events may deter current and potential cyclists [15]. Hamurcu and Eren (2020) identify clean and public transportation optimization as pivotal in developing countries, considering economic, environmental, and social dimensions [16]. Buehler et al. (2020) observe demographic, socioeconomic, and geographic trends in walking and cycling in the U.S., noting an increase in walking but stagnant cycling rates from 2001 to 2017 [17]. Acheampong et al. (2021) report strong preferences for clean fuel vehicles and stress leveraging environmental attitudes and public transport policies for sustainable mobility [18]. Tran et al. (2023) advocate for dynamic traffic modeling to optimize electric vehicle charging infrastructure [3]. In Iran, Pourashka et al. (2014) highlight cycling's significance for short urban trips in Rasht [19], while Zali and Mansouri Birjandi (2014) stress cultural awareness and compact urban design for Tehran's sustainable transport [20]. Ghorbani and Asadi (2015) identify barriers to urban cycling in Zanjan, including cultural and infrastructural issues [21], and Barari (2020) highlights non-motorized transport and accident costs as key

to green transport in Sari [5]. The existing research indicates a gap in strategies for clean transportation in mountainous cities, underscoring the novelty of this study.

The city of Shiraz, with its favorable climate, moderate safety, valuable historical and cultural attractions, suitable employment and business conditions, and adequate healthcare facilities, has historically been one of the nation's major population centers. However, the rapid population growth in recent years has exposed Shiraz to numerous environmental, economic, and socio-cultural challenges. In this regard, the excessive use of motor vehicles and fossil fuels has led to abnormal increases in environmental pollution, including noise and air pollution.

The study area (District Eight of Shiraz) is a historically valuable region encompassing elements such as the Zand Complex, the Bazaar, and unique cultural textures. However, the increasing number of urban trips and the lack of adequate transportation routes have created challenges in this part of Shiraz. Specifically, this area suffers from heavy traffic and significant conflicts between pedestrian and vehicular flows due to high motor vehicle use. Therefore, developing clean transportation strategies for this urban area is highly critical. This research aims to explain strategies for developing clean transportation in District Eight of Shiraz.

2. Methodology

This research was conducted using a combination of descriptive-analytical and survey methods. Data were collected through field methods (questionnaire completion and expert interviews) as well as library research. The library research involved reviewing accessible and relevant research designs, articles, books, and other documents pertinent to the study's subject. In the field data collection phase, opinions and perspectives were obtained from 27 experts and specialists related to urban transportation. The primary tool for collecting field data was a researcher-designed questionnaire. The questionnaire consisted of two sections: personal characteristics of the experts and specialists, and variables related to clean transportation.

To identify the most critical strategies and analyze the collected data, the SWOT model and Excel software were employed. Initially, a list of strengths, weaknesses, opportunities, and threats associated with the development of clean transportation in the studied area was identified through an evaluation of environmental factors related to urban transportation. Subsequently, priorities were determined based on the input of experts and specialists and the weighting of the indicators. In the final stage, strategies for developing clean transportation in District Eight of Shiraz were presented.

3. Findings and Results

The evaluation of the characteristics of the specialists and experts showed that the 27 individuals whose opinions were collected were, on average, between 30 and 39 years old, and most held undergraduate degrees. These individuals were generally specialized in sustainable urban development and urban transportation.

After a comprehensive review of credible and relevant literature, an understanding of the studied area (District Eight of Shiraz), and the identification of factors associated with clean transportation development, the identified factors were categorized as internal (strengths and weaknesses) and external (opportunities and threats) factors related to clean transportation development. Calculations were subsequently conducted. Overall, the SWOT model aims to transform weaknesses into strengths and minimize the system's threats and shortcomings. Ultimately, the model seeks to maximize the use of identified opportunities.

The total weighted score for the most significant strengths of District Eight of Shiraz in clean transportation development was 3.081. Key strengths include cultural homogeneity (0.6), land-use diversity and citizens' inclination towards sports and physical and mental health improvement (0.47), environmental conservation (0.34), the centrality of the district (0.34), citizens' willingness to participate in clean transportation development programs (0.33), the potential for various transportation modes (0.21), smart traffic control (0.20), and pedestrian corridor potential (0.095).

Regarding weaknesses in clean transportation development in District Eight of Shiraz, significant factors include the lack of priority for clean transportation (0.56), high traffic levels and fossil fuel consumption (0.42), noise pollution (0.39), unorganized and unplanned urban development (0.26), narrow road widths, high accident rates, the presence of valuable historical-cultural buildings (0.25), air pollution (0.16), dilapidated urban fabric, and insufficient promotion of clean transportation (0.14). Addressing these weaknesses requires comprehensive planning.

Table 1. SWOT Analysis of Internal Factors Related to Clean Transportation Development in Central Shiraz

Strengths (S)	Weight	Rank	Weighted Score	Weaknesses (W)	Weight	Rank	Weighted Score
Citizen willingness to participate	0.1115	3	0.3345	Dilapidated urban fabric	0.0746	2	0.1491
Environmental conservation	0.1142	3	0.3426	Air pollution	0.0813	2	0.1626
Cultural homogeneity	0.1214	5	0.6070	Noise pollution	0.0981	4	0.3925
Potential for development	0.1056	2	0.2112	Narrow road widths	0.0851	3	0.2554
Smart traffic control potential	0.1010	2	0.2020	Presence of valuable buildings	0.0847	3	0.2540
Interest in health improvement	0.1188	4	0.4752	High accident rates	0.0861	3	0.2583
Land-use diversity	0.1181	4	0.4724	Insufficient clean transportation promotion	0.0746	2	0.1491
Pedestrian corridor potential	0.0958	1	0.0958	High traffic levels	0.1063	4	0.4252
Central district location	0.1135	3	0.3405	Lack of clean transportation priority	0.1130	5	0.5652
-	-	-	-	Fossil fuel dependency	0.1068	4	0.4271
-	-	-	-	Unplanned urban growth	0.0895	3	0.2684
Total	1	-	3.0812	Total	1	-	2.6114

Key opportunities for achieving clean transportation development in central Shiraz include government organizations' willingness to support clean transportation development (0.69), no requirement for advanced technology (0.52), increased potential for social cohesion through clean transportation (0.51), private sector interest in investing in clean transportation (0.38), public interest, especially among women (0.36), and the importance of tourism in the district (0.35).

Conversely, significant threats include high crime rates in the district (0.52), neglect of clean transportation in traffic policy-making (0.51), difficulty in modifying the existing urban space (0.50), lack of a comprehensive clean transportation plan (0.42), and misalignment between urban and clean transportation plans (0.36). Addressing these threats is essential for meeting the medium- and long-term goals of cities.

Table 2. Results of External Factor Analysis for Clean Transportation Development Strategies in Central Shiraz

Opportunities (O)	Weight	Rank	Weighted Score	Threats (T)	Weight	Rank	Weighted Score
O1: Interest in investment	0.1270	3	0.3811	T1: Difficulty in changes	0.100	5	0.501
O2: Governmental commitment	0.1393	5	0.6967	T2: Lack of coordination	0.092	4	0.367
O3: Tourism	0.1178	3	0.3533	T3: Population density	0.116	2	0.232
O4: No need for technology	0.1324	4	0.5296	T4: Activity interference	0.077	2	0.154
O5: Citizen awareness	0.1139	2	0.2279	T5: High crime rates	0.105	5	0.523
O6: Citizen engagement	0.1232	3	0.3695	T6: Poor traffic policies	0.102	5	0.512
O7: Potential for urban renewal	0.1186	3	0.3557	T7: Lack of awareness	0.093	4	0.372
O8: Social cohesion	0.1278	4	0.5112	T8: No comprehensive plan	0.107	4	0.429
				T9: Ineffective regulations	0.116	3	0.347
				T10: Socioeconomic gaps	0.092	4	0.369
Total	1	-	3.4255	Total	1	-	3.3805

The figure below illustrates the tendency of the SWOT chart toward the system's opportunities and threats, emphasizing the need for comprehensive planning to convert opportunities into strengths and to avoid threats becoming weaknesses.

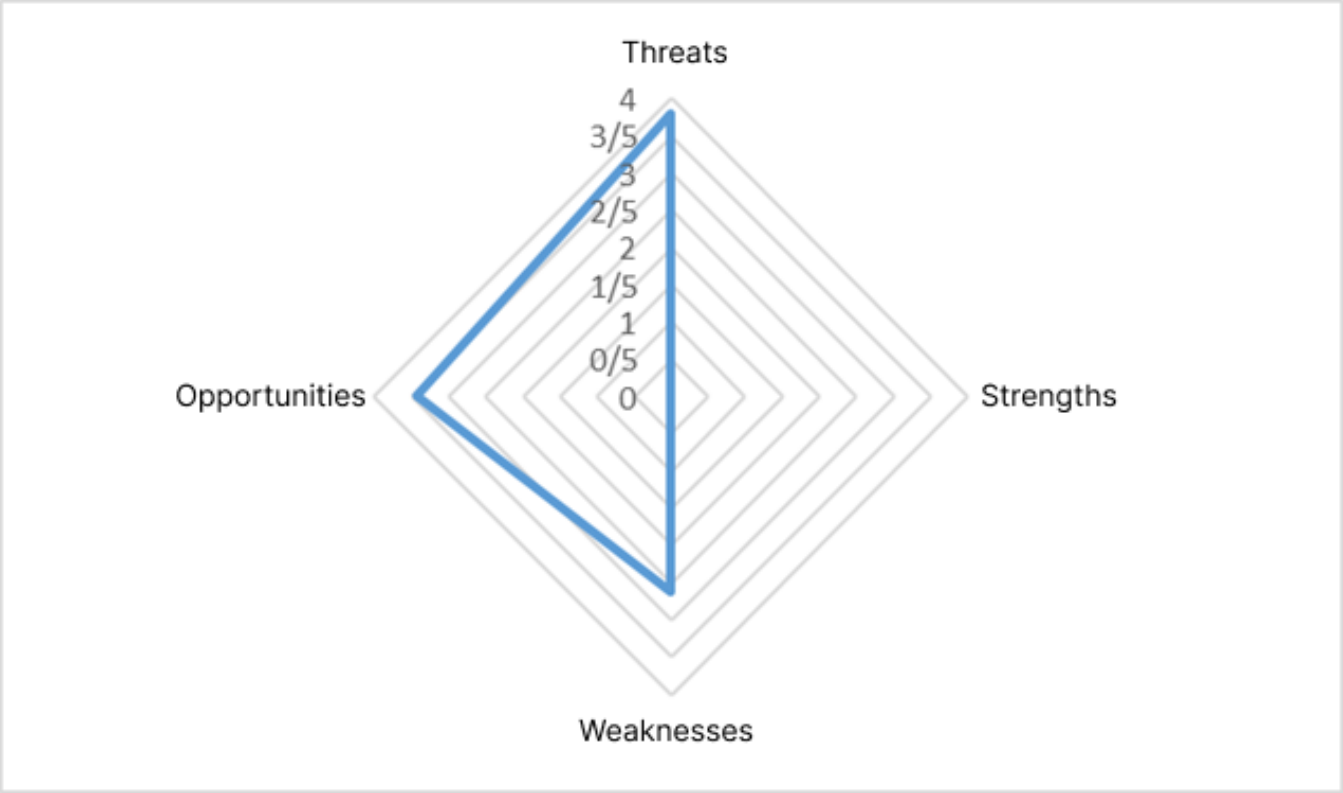

Figure 1. Comparative SWOT Analysis of Strengths, Weaknesses, Opportunities, and Threats

SO Strategies

These strategies focus on designing and implementing solutions to develop clean transportation in central Shiraz by leveraging existing strengths and opportunities.

- **SO1**: Design programs to encourage public participation in environmental protection initiatives.
- **SO2**: Increase competitiveness among organizations to promote clean transportation development.
- **SO3**: Diversify transportation options to facilitate tourist access.
- **SO4**: Implement artificial intelligence and smart systems for traffic control.
- **SO5**: Organize free public sports programs and raise citizen awareness through campaigns.
- **SO6**: Develop pedestrian-focused infrastructure to enhance vitality and social interactions.
- **SO7**: Engage citizens and incorporate their input to improve program execution quality and reduce excessive organizational costs.

ST Strategies

These strategies leverage existing strengths in central Shiraz to mitigate threats to clean transportation development.

- **ST1**: Encourage citizens to use clean transportation to reduce traffic congestion.
- **ST2**: Implement incentive and penalty policies to foster the adoption of clean transportation.
- **ST3**: Use mass media to promote clean transportation and raise public awareness.
- **ST4**: Ensure coordination and integration among urban organizations' plans to prevent conflicts and project failures.
- **ST5**: Provide diverse transportation options to meet the needs of all social groups.
- **ST6**: Enforce regulations to improve implementation quality and prevent administrative corruption.

WO Strategies

These strategies emphasize using opportunities to overcome weaknesses in the path toward clean transportation development in central Shiraz.

- **WO1**: Provide necessary facilities to encourage clean transportation usage and reduce pollution and fossil fuel consumption.

- **WO2**: Attract public and private investment toward clean transportation through appealing advertisements.
- **WO3**: Utilize information tools and software to highlight the benefits of clean transportation, reducing traffic and accidents.
- **WO4**: Create incentives for renovating historical and deteriorating urban areas.
- **WO5**: Foster a sense of place among citizens and enhance social interactions in urban public spaces.

WT Strategies

These defensive strategies aim to minimize weaknesses and avoid threats in clean transportation development in central Shiraz.

- **WT1**: Implement planned programs for clean transportation to reduce traffic and pollution problems.
- **WT2**: Develop appealing promotional mechanisms to motivate public adoption of clean transportation.
- **WT3**: Revise urban plans and adopt principles that integrate clean transportation.
- **WT4**: Continuously monitor and control prepared and implemented activities.

After completing the above steps, the proposed strategies for the development of clean transportation in District Eight of Shiraz were prioritized using the QSPM matrix. Each strategy was individually compared with the system's strengths, weaknesses, opportunities, and threats. The final scores of the strategies were then compared, and their ultimate priority rankings were determined. The table below shows the average scores of the ST, WT, WO, and SO strategies. The data indicate that the average score of the ST strategy, at 46.12, is higher than the other strategies.

Table 3. Scores of Effective Strategies for Developing Clean Transportation in the Studied Area

Strategy Type	SO	WO	WT	ST
Average	43.09	42.96	45.40	46.12

The highest-scoring strategies include:

1. Providing necessary facilities for using clean transportation to reduce pollution.
2. Offering diverse transportation plans for the general public.
3. Utilizing mass media to promote clean transportation and raise public awareness.

Table 4. Clean Transportation Development Strategies in Central Shiraz: Priority Rankings and Planning Timelines

Type	Strategy	Weighted Score	Priority	Short-Term Plan	Mid-Term Plan	Long-Term Plan
SO	Design programs to encourage public participation in environmental protection initiatives.	45.03	10		✓	
	Increase competitiveness among organizations to develop clean transportation.	39.50	19			✓
	Diversify transportation options to facilitate tourist access.	42.14	13		✓	
	Implement AI and smart systems for traffic control.	39.88	18			✓
	Organize free public sports programs and raise citizen awareness through campaigns.	41.30	15	✓		
	Develop pedestrian-focused infrastructure to enhance vitality and social interactions.	46.05	8	✓		
	Engage citizens and incorporate their input to improve program execution and reduce costs.	47.76	5		✓	
ST	Encourage citizens to use clean transportation and reduce traffic congestion.	40.62	16		✓	
	Implement incentive and penalty policies to promote clean transportation.	47.73	6			✓
	Use mass media to promote clean transportation and raise public awareness.	48.52	3	✓		
	Coordinate urban organization plans to prevent conflicts and project failures.	41.43	14			✓
	Offer diverse transportation plans for public use.	49.63	2		✓	
	Enforce regulations to ensure quality and prevent administrative corruption.	48.82	3	✓		

WO	Provide facilities for clean transportation to reduce pollution and fossil fuel consumption.	50.44	1		✓		
	Attract public and private investment through appealing advertisements.	40.43	17		✓		
	Use informational tools to highlight the benefits of clean transportation and reduce traffic accidents.	45.77	9	✓			
	Create incentives to renovate deteriorated and historical areas.	39.40	20			✓	
	Foster a sense of place among citizens and enhance social interactions in public spaces.	38.76	21		✓		
WT	Implement planned clean transportation programs to reduce traffic and pollution.	47.09	7		✓		
	Develop engaging promotional mechanisms to motivate public adoption of clean transportation.	44.04	11	✓			
	Revise urban plans to incorporate clean transportation strategies.	42.72	12	✓			
	Continuously monitor and control the implementation of planned activities.	47.78	4		✓		

The strategies with the lowest scores include fostering a sense of place among citizens, creating incentives for renovating deteriorated and historical areas, and increasing competitiveness among organizations to promote clean transportation. The execution timeline for each proposed strategy is categorized into short-term, mid-term, and long-term planning stages, as detailed in Table 4.

4. Discussion and Conclusion

In this research, the SWOT model was used to formulate strategies, and a combination of SWOT and AHP was employed to quantify the approach. After formulating the strategies, calculating their relative and absolute weights, and determining the final weighted scores, the prioritized strategies were identified. The strategies, ranked by priority, are as follows: ST (46.12), WT (45.40), SO (43.09), and WO (42.96). Therefore, the superior strategy is the ST strategy. In other words, for the development of clean transportation in the central area of Shiraz, the urban strategy for this district should be adaptive or diversified (ST).

This strategy, based on a "maximum-minimum" approach, focuses on leveraging internal strengths to counter external threats. It aims to maximize strengths and minimize threats. Key elements of this strategy include encouraging citizens to use clean transportation and reduce traffic congestion, implementing incentive and penalty policies to promote clean transportation, utilizing mass media to raise awareness and educate various social groups about clean transportation, ensuring coordination and integration of urban management organizations' programs to prevent conflicts and project failures, offering diverse transportation options to cater to all social groups, and enforcing necessary laws and regulations to improve execution quality and prevent administrative corruption.

A comparison of the findings of this study with related research shows that, regarding citizens' willingness to use clean fuels (electric and hybrid), this study's results differ from some findings [18]. Conversely, in emphasizing the optimization and development of clean transportation, considering the roles of city managers and residents, and taking into account urban environmental, economic, and social factors, this study aligns with prior findings [16]Additionally, it shares common ground with the study by Zali and Mansouri-Birjandi (2022) in highlighting the role of cultural awareness [20].

Recommendations for the Development of Clean Transportation in Central Shiraz:

- Emphasize preserving the urban environment to strengthen and develop clean transportation in the studied area.
- Utilize the capacity of the Dry River area to enhance clean transportation in the region.
- Improve foreign relations at a macro level to attract international investment in the transportation sector.
- Provide appropriate incentives to attract domestic investors.
- Foster peaceful coexistence among various social groups within the city.
- Create opportunities for women to access clean transportation facilities.
- Increase citizens' awareness and understanding of the benefits of clean transportation.
- Enhance the integration of information and communication technology in the clean transportation sector.
- Improve lighting conditions along routes and at stations used for clean transportation.

- Enhance the safety of routes and stations dedicated to clean transportation.
- Strengthen communication and coordination among urban management organizations during the planning and implementation of clean transportation projects.
- Organize specialized training courses to improve the skills and capabilities of urban managers for advancing clean transportation.
- Draft flexible and new legislation while phasing out ineffective regulations.

Authors' Contributions

Authors equally contributed to this article.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

All procedures performed in this study were under the ethical standards.

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