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Assessing Road Users' Preferences for Various Travel Demand Management Strategies for Adoption in Accra, Ghana

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Abstract: The rise in population density, vehicle ownership, and urban development has significantly influenced travel demand and altered travel patterns, leading to traffic congestion in rapidly growing urban centers such as Accra, Ghana. The traditional approach of expanding roadways to accommodate rising traffic is no longer environmentally sustainable. Instead, the emphasis has shifted toward travel demand management (TDM) strategies as a more sustainable solution. This study aimed to investigate a range of TDM strategies that can be adopted in Accra to improve traffic flow through the lenses of everyday road users. The study employed a questionnaire survey and a stratified sampling technique to gather data from 615 respondents for relative importance index (RII) ranking and Chi-square statistical analysis. The findings revealed that the topmost preferred strategies were mass transit improvements, walking and cycling improvements, and alternative work schedules. Notably, mass transit improvements emerged as the most preferred strategy. Conversely, strategies like efficient parking pricing, congestion pricing, and higher fuel and road taxes for private vehicles ranked lowest, garnering minimal preference. The study also revealed a statistically significant correlation between variables such as age, education level, marital status, income level, and mode of transportation and all the selected TDM preferences. However, no significant relationship was found between gender or car ownership and any of the selected TDM preferences. The study provides valuable insights into road users' preferences for TDM strategies that can aid in planning future urban mobility systems to proactively manage travel demand, alleviate congestion, and promote sustainable transportation options for the city's residents.

Keywords: Accra; congestion; mass transit improvements; travel demand management strategies; walking and cycling improvements

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1. Introduction

Transportation planning is undergoing a paradigm shift, moving from a traffic-based analysis approach to an accessibility-based analysis paradigm. This transformation considers personal and freight travel speed and costs as well as people's and businesses' ability to reach desired services and activities. Access to goods, services, and destinations plays a pivotal role in this new approach. By redefining the efficiency of transport systems, this approach aims to improve overall transportation planning [1]. With the increase in urbanization, the frequency of travel within urban areas has increased, which has resulted in congestion. Traffic congestion has become an unavoidable challenge in large and growing metropolitan areas globally as travel demand exceeds the capacity of existing transportation infrastructure [2]. This problem is particularly severe in rapidly urbanizing cities, such as Accra, Ghana, where public transport struggles to meet the mobility needs of the urban population due to increasing demand [3]. Traditionally, cities have approached this increased mobility demand by expanding transportation options, primarily by constructing new highways and transit lines. The focus has predominantly been on building more roads to accommodate the ever-increasing number of vehicles. As a result, various urban spatial structures have emerged with dependence on automobiles serving as the primary differentiating factor. The extent and growth of transportation infrastructure differ among cities globally, leading to diverse urban configurations and transportation systems. Consequently, urban sprawl has become a prevalent phenomenon that manifests differently in cities with distinct characteristics [4].

To address the issues of congestion and improve urban transportation, a viable solution is the implementation of travel demand management (TDM) strategies. TDM is defined as a strategy aimed at optimizing the efficiency of urban transportation systems. Its core objective is to reduce reliance on private vehicles and promote the adoption of more efficient, health-conscious, and environmentally friendly modes of transportation, such as public transit and non-motorized options [5,6]. It comprises various approaches and techniques that influence travel behavior within the evolving landscape of transportation system performance, promoting sustainable mobility and improved overall system effectiveness [7]. TDM focuses on managing demand efficiently rather than expanding infrastructure to match demand. TDM strategies can also be classified based on their approach either as pull or push strategies. Pull measures encourage travelers to use sustainable modes of transportation by providing attractive alternatives, such as improved public transport or vanpooling, while push measures discourage the use of unsustainable modes of transportation by increasing fuel and road taxes, among other policies [8]. Babb and Smith [8] classified TDM strategies into nine categories using a cumulative strategy matrix, ranging from pull to push strategies.

Table 1 below summarizes the best practices of TDM strategies. These strategies offer travelers choices to enhance travel reliability, such as work location, travel route, travel timing, and travel mode [9]. During the COVID-19 pandemic, transportation patterns were significantly affected; however, businesses resorted to TDM strategies such as remote work and digital technologies to continue operations [10,11].

Table 1. TDM strategy matrix (adapted from Babb and Smith [8]).

	TDM Category	**Examples of TDM Strategies**
Pull	Improvement in alternative modes	Cycling improvements, pedestrian improvements, shuttle service, non-motorized transport (NMT), public bike system, car sharing, transit improvements, complete streets
	Planning-integrated land use and transport	New urbanism. TOD, car-free planning, land use density and clustering, location-efficient development
	Workplace-based instruments	Alternative work schedules, flextime, teleworking, commuter financial incentives
	Travel behaviors change programs	Transit, walk, and cycling encouragement
	Information programs	Multi-modal navigation tools
Push	Road space management	Traffic calming, road space reallocation
	Governance	Smart growth reforms, institutional reforms, participatory planning, regulatory reform
	Parking	Park and ride, parking pricing, parking management, shared parking
	Taxes and Charges	Road pricing, vehicle use restriction, carbon taxes, congestion pricing, fuel tax

When evaluating these strategies, it is crucial to examine the factors affecting the acceptability and success of specific TDM strategies. The acceptance of TDM strategies will be high if the socioeconomic and travel characteristics of road users are properly considered [12]. In developing countries, numerous studies have demonstrated that socioeconomic factors such as income, occupation, car ownership, education, and gender significantly influence the acceptance and effectiveness of TDM strategies [12–14]. Other factors identified by researchers include travel-related strategies such as individual lifestyle, societal norms, personal freedom in mode choice, and varying attitudes [15–19]. Some studies have shown that different attitudes and the changing nature of society significantly influence individual behavior [15,20,21]. Additionally, personality characteristics such as feelings of power, status, and superiority also impact travel behavior to some extent [15,22,23].

Accra, the capital city of Ghana, relies heavily on the traditional semiformal "trotro" system as its primary mode of public transportation. However, this system is plagued by issues such as unreliability, low service standards, and frequent traffic congestion. Recognizing these challenges, the Aayalolo Bus Service (ABS) was introduced as a rudimentary rapid transit system for buses. Unfortunately, it faced various obstacles, leading to its temporary suspension and the subsequent adoption of a "fill and go" service during peak hours [24]. Presently, alternative transportation options such as colored taxi cabs, motorcycles (known as Okada), private vehicles, and technology-based ride-hailing services have gained popularity among commuters in Accra. Autorickshaw transit is also an emerging mode of intracity transit in urban cities in Ghana [25,26]. Nonetheless, save autorickshaws, these alternatives come at a higher cost. Each of these transportation choices caters for different consumers with diverse socioeconomic backgrounds [27,28]. To address the existing transportation issues and develop an efficient system that meets the city's growing demands, this paper aims to explore the potential for implementing innovative TDM strategies in Accra, Ghana. Exploring TDM strategies in Accra, Ghana, holds the potential to address pressing transportation challenges while advancing broader social, economic, and environmental goals for sustainable urban development. Assessing best practices for adoption in Accra involves evaluating successful TDM initiatives from other similar contexts and tailoring them to suit the city's specific needs, constraints, and priorities.

2. Theoretical Framework for the Study

From the review of literature, few studies have examined the effects of sociodemographic characteristics on TDM preferences. Pradono et al. [12] highlighted that sociodemographic factors play a significant role in shaping TDM strategy preferences. Consequently, this study aimed to examine road users' preferences for various TDM strategies in Accra, Ghana, and explore the relationship between these preferences and sociodemographic factors. To achieve this, a theoretical framework has been proposed (Figure 1). It was hypothesized that there is a relationship between sociodemographic characteristics such as age, gender, education level, marital status, employment status, income level, mode of transportation, car ownership, and the choice of different TDM strategies. According to this framework, the independent variables are age, gender, education level, marital status, employment status, income level, mode of transportation, and car ownership, while the dependent variable is TDM strategies. Figure 1 illustrates the theoretical framework of this study, which guided the research.

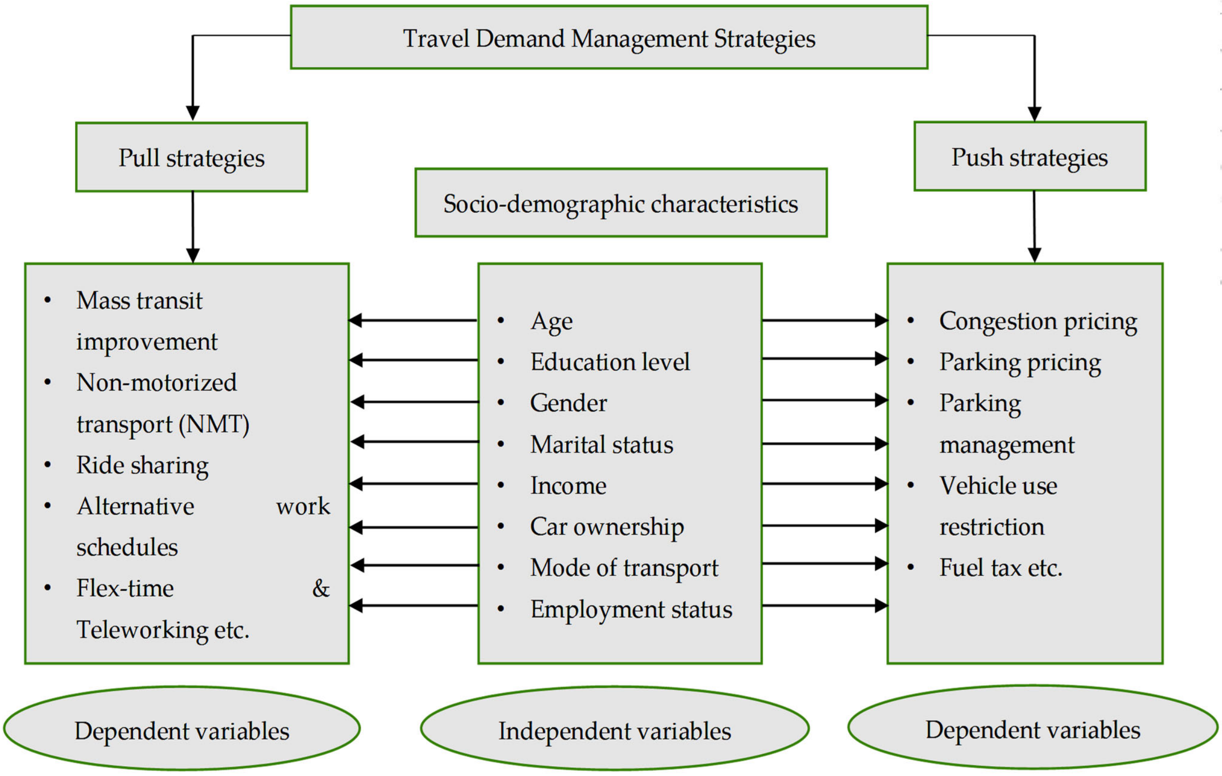

Figure 1. The theoretical framework for the study (author's construct).

3. Materials and Methods

3.1. Questionnaire Design

The questionnaire was designed based on criteria established from a literature review and expert discussions. The questionnaire was divided into two sections: section A, which focused on gathering demographic characteristics, and section B, which was dedicated to assessing attitudes toward TDM strategies. Section B employed a 5-point Likert scale to measure agreement with a scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaires were composed of only close-ended questions. Subsequently, the questionnaires were distributed to respondents to ascertain their level of agreement with various TDM strategies.

3.2. Sample Size Determination and Sampling Technique

To determine a suitable sample size for the population, the study adopted Tara Yamane's method as described by Tepping [29]. Based on the information available from the Ghana Statistical Service (GSS) in 2021, the total population of Accra Metropolis was reported to be 284,124 residents [30]. Employing a confidence level of 95%, the calculated sample size (n) was established as 400. However, due to the importance of obtaining a comprehensive dataset, the researcher collected more data. In total, 615 questionnaires were distributed, which is significantly larger than the initial calculated sample size. This large sample size provided a broader range of responses and increased the statistical power of the analysis. This sample size estimated for the study was deemed adequate to provide a good representation of the population. All 615 distributed questionnaires were returned, yielding a response rate of 100%. The survey employed a stratified sampling technique, which enabled the researchers to select the groups mentioned above that were scattered throughout the Accra Metropolis.

Mathematically, Yamane's formula is expressed as follows:

$$n = \frac{N}{1 + N(e)^2} \tag{1}$$

where n represents the sample size, N denotes the population of the study (284,124) and e signifies the margin error in the calculation (5%).

3.3. Data Collection

The research employed both primary and secondary sources of data collection. Primary data were obtained by employing a questionnaire survey. Additionally, secondary data were acquired through a comprehensive examination of the pertinent literature. Respondents were allowed to complete the survey at their convenience with regular reminders provided. The data collection process was conducted over a period of six (6) weeks, from 12 April 2023 to 26 May 2023. The survey employed both in-person interviews and an online database via Google Forms link. Invitations to participate were sent to individuals who had expressed interest. These invitations were disseminated through several platforms, including WhatsApp and email, to ensure a broad reach and encourage diverse participation. The Google form software includes built-in checks to ensure all questions are answered appropriately and can prompt respondents if they miss a question. The questionnaire was designed to target potential road users from diverse groups which include private vehicle owners, public transportation users, pedestrians, and cyclists of various age groups, genders, income ranges, education levels, employment statuses, and different means of transport residing in the Accra metropolis.

3.4. Data Analysis

Data processing and analysis were performed using Microsoft Excel and SPSS statistical software. Descriptive statistical analyses in the form of frequencies and percentages were computed for all sociodemographic variables. The TDM strategies were all examined, and their attributes were ranked using the relative importance index (RII). This RII calculation allowed for a quantitative assessment of the preferences for different TDM strategies based on the responses gathered from the questionnaires. To calculate the RII for the preference of various TDM strategies, the formula outlined by Tawil et al. [31] in Equation (2) was employed. The formula is expressed as follows:

$$\mathrm{RII} = \frac{1\mathrm{n}_1 + 2\mathrm{n}_2 + 3\mathrm{n}_3 + 4\mathrm{n}_4 + 5\mathrm{n}_5}{5(\mathrm{n}_1 + \mathrm{n}_2 + \mathrm{n}_3 + \mathrm{n}_4 + \mathrm{n}_5)} \quad (2)$$

where n_1 represents respondents who strongly disagree, n_2 represents those who disagree, n_3 represents those who are neutral, n_4 represents those who agree, and n_5 represents those who strongly agree.

The RII value has a range from 0 to 1 (0 not inclusive) and has been categorized into five levels of importance, as shown in Table 2 [32].

Table 2. Relative importance index rating criteria.

RII Values	Importance Level	
From 0.8 to 1	High	H
From 0.6 to 0.8	High–medium	H–M
From 0.4 to 0.6	Medium	M
From 0.2 to 0.4	Medium–low	M–L
From 0 to 0.2	Low	L

Additionally, the analysis included the application of Pearson's Chi-square test of independence to examine the relationship between sociodemographic factors such as gender, age, income, education level, car ownership, and mode of transport with several selected TDM strategies. The predictors according to Pearson's Chi-square test were considered significant at a *p*-value of 0.05 or lower. The following assumptions for the Chi-square test were met:

Assumption 1. *The data in the cells were frequencies or counts of cases rather than percentages or other transformations.*

Assumption 2. *The levels or categories of the variables were mutually exclusive, meaning each subject fit into one and only one level of each variable.*

Assumption 3. *Each subject contributed data to only one cell in the Chi-square test.*

Assumption 4. *The study groups were independent.*

Assumption 5. *At least 80% of the cells had expected frequencies of 5 or more, and no cell had an expected frequency of less than one.*

Mathematically, Pearson's Chi-square test formula is given as follows [33]:

$$X^2 = \sum_{i=1}^{n} \frac{\left(O_i - E_i\right)^2}{E_i} \tag{3}$$

where O_i is the observed value, E_i represents the expected value, and X^2 is the Chi-square value.

3.5. Reliability Analysis

The questionnaire responses were subjected to an internal consistency assessment via SPSS. The reliability of the Likert scale items was assessed through Cronbach's alpha. Cronbach's alpha coefficient was employed to determine the reliability of the questionnaire contents in producing accurate responses. According to Tarek et al. [32] reliability levels below 0.5 are unacceptable, 0.6–0.69 are poor, 0.7–0.79 are acceptable, 0.8–0.89 are good, and levels above 0.9 are excellent. The analysis of the survey data revealed an acceptable reliability coefficient of 0.767 for the ranking-related questions [32].

4. Study Area

The study was conducted in the Accra metropolis, which is one of the district assemblies within the Greater Accra Region of Ghana. This local government district covers Accra's historical center and primary central business district (CBD) [34]. According to the Ghana Statistical Service (2021), the Accra Metropolis has a total population of 284,124 residents [30]. Road transportation is Ghana's primary mode of travel, serving both freight and passengers. Train and waterway transport, particularly on the Volta Lake (the country's only navigable water body), are in the early stages of development. Private car usage accounts for approximately 15% of the population, while the majority, 85%, rely on public transport or walking [35]. Public transportation in Ghana mainly comprises taxis, trotro (minibus fleets), and commuter buses serving intra and intercity routes. The railway system, established during the colonial era, has encountered challenges but is currently undergoing revitalization efforts. Furthermore, emerging modes of transport, especially in rural and urban areas, are the two and three-wheel motorcycles, which are locally known as "okada" and "pragya", respectively [26,36]. Figure 2 below displays a map of the area.

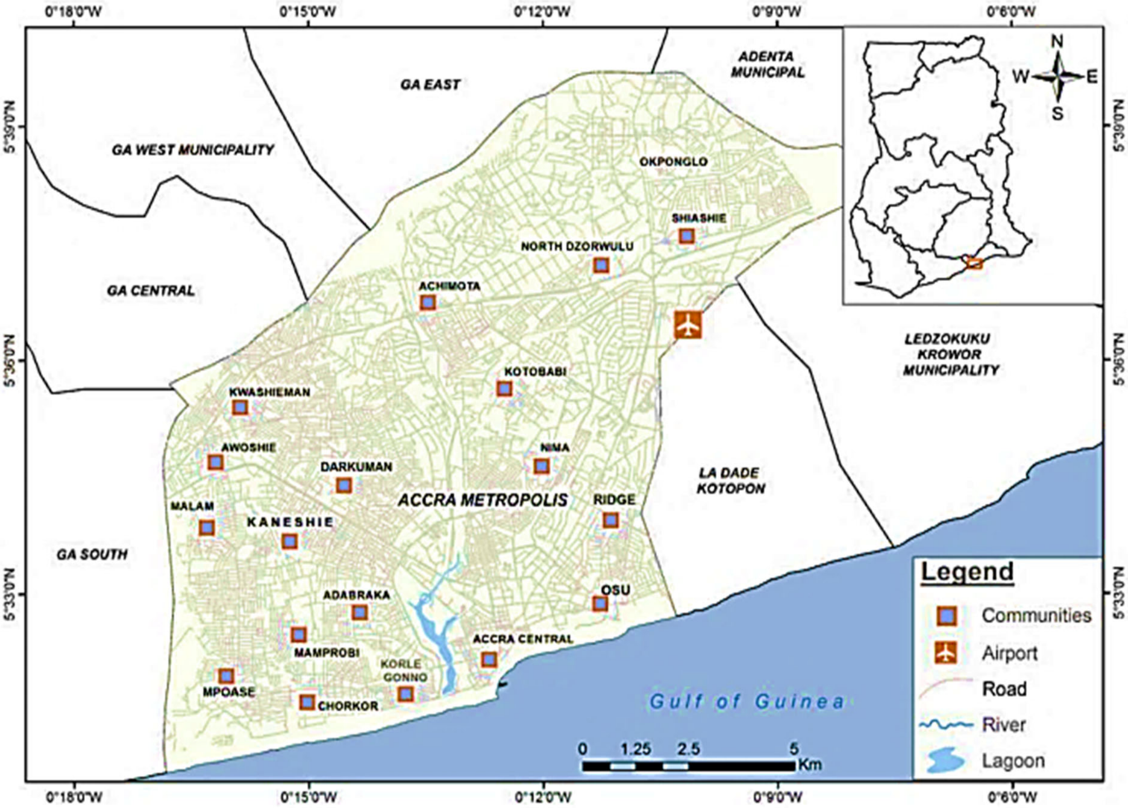

Figure 2. Map of Accra metropolis (source: Accra Metropolitan Assembly [37]).

5. Results

5.1. Descriptive Analysis

Table 3 illustrates the sociodemographic characteristics pertaining to the social status of the survey participants. Out of the total sample, 62.3% of the population was identified as male, while 37.7% was identified as female. Additionally, in terms of age distribution, the majority of the participants were aged 36–40 years (18.5%) and 41–45 years (18.5%) with the smallest proportion being aged younger than 20 years (3.10%). Regarding marital status, 68.6% of the individuals were married, while 18.4% were single. A total of 7.60% of the individuals were divorced and 5.40% were widowed. Regarding education level, the highest proportion had undergone second-cycle education (50.4%), which was followed by bachelor's degree holders (20.2%). Only a small percentage had no formal education (1.3%), while postgraduate degree holders constituted 3.3% of the population.

Furthermore, the employment status indicates that the majority were employed (90.7%), while 9.30% were unemployed. In terms of income, the largest percentage of participants fell within the GH₵501–1500 bracket (61.5%), while only a small proportion had incomes above GH₵6500 (1.50%). Car ownership was relatively low, with only 13.0% of the population owning a car, while 87.0% did not. The mode of transport primarily consisted of bus/trotro (85.7%), followed by private car (11.1%), with foot mobility/walking and motorcycle/bicycle constituting smaller percentages (1.6% each) [35]. Finally, a smaller fraction, (1.6%), used motorcycles/bicycles or chose to walk. Regarding traffic congestion in the Accra metropolis, 96.6% of respondents agreed that they regularly experienced traffic congestion in the area.

Table 3. Sociodemographic characteristics of the respondents.

Variable	Category	Count	Percent (%)
Gender	Male	383	62.3
	Female	232	37.7
Age	Below 20 years	19	3.10
	21–25 years	5	0.80
	26–30 years	45	7.30
	31–35 years	76	12.4
	36–40 years	114	18.5
	41–45 years	114	18.5
	46–50 years	104	16.9
	Above 50 years	138	22.4
Marital status	Single	113	18.4
	Married	422	68.6
	Divorced	47	7.60
	Widowed	33	5.40
Education level	No formal education	8	1.3
	Basic education	60	9.8
	Second cycle education	310	50.4
	Higher National Diploma	93	15.1
	Bachelor's degree	124	20.2
	Postgraduate degree	20	3.3
Employment status	Employed	558	90.7
	Unemployed	57	9.30
Income	Below GH₵500	41	6.70
	GH₵501–1500	378	61.5
	GH₵1501–2500	109	17.7
	GH₵2501–3500	56	9.10
	GH₵3501–4500	13	2.10
	GH₵4501–5500	7	1.10
	GH₵5501–6500	2	0.30
	Above GH₵6500	9	1.50
Car ownership	Yes	80	13.0
	No	535	87.0
Mode of transport	Foot mobility/Walking	10	1.6
	Motorcycle/Bicycle	10	1.6
	Bus/Trotro	527	85.7
	Private car	68	11.1

Note: 1 USD = GH₵11.33 at the time of the data collection.

5.2. Preferential Ratings for Different TDM Strategies

The preferences of road users toward different TDM strategies were analyzed based on their relative importance index ranking. The relative importance indices and ranks of the different TDM strategies are presented in Table 4 below.

Respondents ranked mass transit improvements as the most preferred TDM strategy with an RII of 0.921. This ranking aligns with the prevailing trend of prioritizing mass transit enhancement globally, exemplified by the ongoing construction of bus rapid transit (BRT) systems, aimed at bolstering bus service convenience, speed, and integration [38]. The second most preferred strategy was walking and cycling improvement with an RII of 0.884. This outcome comes as no surprise, considering that walking and cycling are widely recognized as the most sustainable modes of transportation [39]. Several factors, including cost, convenience, and familiarity with the strategy, could explain road users' high preferences for mass transit and walking and cycling improvements. Respondents also believe that alternative work schedules, and staggered school and work hours, can help reduce the number of employees arriving and leaving a worksite at a time. These strategies were ranked third and fourth with RIIs of 0.872 and 0.852, respectively, indicating their significant perceived importance and desirability among the respondents. These strategies aim to streamline travel demand by minimizing peak-hour traffic congestion and fostering a more efficient distribution of travel patterns. By adopting alternative work schedules and staggered hours, organizations can contribute to easing traffic congestion during peak periods [40].

Table 4. Preferential rankings of different TDM strategies.

Item	Travel Demand Management Strategies	RII	Rank
a.	Mass transit improvements	0.921	1
b.	Walking and cycling improvements	0.884	2
c.	Alternative work schedules	0.872	3
d.	Staggered school and work hours	0.852	4
e.	Introducing school bus	0.845	5
f.	Ridesharing (car-pooling)	0.836	6
g.	Introducing staff bus	0.828	7
h.	Park and ride	0.807	8
i.	Parking management	0.806	9
j.	Teleworking (work from home)	0.734	10
k.	Private vehicles use restriction	0.671	11
l.	Car sharing	0.612	12
m.	High occupancy vehicle (HOV) lane priority	0.570	13
n.	Efficient parking pricing	0.539	14
o.	Congestion pricing	0.504	15
p.	Increased fuel and road tax on private vehicles	0.492	16

The TDM strategy preference ranking list suggests that among the various TDM strategies, efficient parking pricing, congestion pricing, and increased fuel and road taxes on private vehicles received relatively low preference scores. The RIIs for these strategies were 0.539, 0.504, and 0.492, respectively. The lower preference for congestion parking pricing strategies and increased fuel and road taxes on private vehicles among road users can be attributed to increased costs (additional costs), perceived unfairness, perceived inconvenience, and lack of awareness. Efficient parking pricing implies that more parking is charged, congestion pricing involves fees for using congested roads, and increased fuel and road taxes directly increase the financial burden on private vehicle owners. Respondents may be less supportive of these strategies because they perceive them as financially burdensome or may have concerns about the overall economic impact on their travel expenses. It is important to note that the RII scores are a measure of relative importance, and the lower scores for these strategies suggest that compared to other TDM strategies, they are less favored among respondents.

5.3. Chi-Square Analysis of the Associations between Sociodemographic Characteristics and Selected TDM Strategies

A further investigation was conducted to explore the connection between the sociodemographic factors of participants and some selected TDM strategies. This approach facilitated the application of the Chi-square test for independence, which aimed to establish whether a substantial association existed between the two categorical variables under scrutiny. The Chi-square tests were used to examine the relationships between the sociodemographic characteristics and several selected TDM strategies such as mass transit improvements, walking and cycling improvements, efficient parking pricing, and increased fuel and road taxes on private vehicles.

5.3.1. Relationships between Mass Transit Improvement Preferences and Sociodemographic Characteristics

The Chi-square (χ^2) test results, as presented in Table 5, revealed the relationships between mass transit improvement preferences and sociodemographic characteristics.

The analysis revealed a significant association between mass transit improvement preference and the following variables: age (χ^2 = 90.516, *p*-value = 0.000), education level (χ^2 = 68.195, *p*-value = 0.000), marital status (χ^2 = 51.655, *p*-value = 0.000), employment status (χ^2 = 10.272, *p*-value = 0.016), income level (χ^2 = 48.003, *p*-value = 0.001), and mode of transport (χ^2 = 30.135, *p*-value = 0.000). Conversely, no statistically significant relationships were detected between mass transit preference and gender (χ^2 = 4.293, *p*-value = 0.231) or between mass transit preference and car ownership (χ^2 = 1.404, *p*-value = 0.702).

Table 5. Chi-square test for the relationship between mass transit improvement preference and sociodemographic characteristics.

Sociodemographic Variables	X^2 Values	df	*p*-Values
Age	90.516	21	0.000
Gender	4.293	3	0.231
Education level	68.195	15	0.000
Marital status	51.655	9	0.000
Employment status	10.272	3	0.016
Income level	48.003	21	0.001
Mode of transportation	30.135	9	0.000
Car ownership	1.404	3	0.705

Note: $p \leq 0.05$, df = degree of freedom.

5.3.2. Relationships between Walking and Cycling Improvement Preferences and Sociodemographic Characteristics

Table 6 displays the results of the Chi-square tests, which investigate the correlation between preferences for walking and cycling improvements and various sociodemographic characteristics. The analysis revealed a significant association between walking and cycling improvement preference and the following variables: age (χ^2 = 192.583, *p*-value = 0.000), education level (χ^2 = 210.153, *p*-value = 0.000), marital status (χ^2 = 140.074, *p*-value = 0.000), employment status (χ^2 = 69.608, *p*-value = 0.000), income level (χ^2 = 214.429, *p*-value = 0.000), and mode of transport (χ^2 = 26.312, *p*-value = 0.010). Conversely, no statistically significant relationships were detected between mass transit preference and gender (χ^2 = 6.059, *p*-value = 0.195) or between mass transit preference and car ownership (χ^2 = 5.094, *p*-value = 0.278). These results indicate that various sociodemographic factors significantly impact preferences for increased fuel and road taxes on private vehicles, whereas other factors do not have a significant impact.

Table 6. Chi-square test for the relationship between walking and cycling improvement preferences and sociodemographic characteristics.

Sociodemographic Variables	X^2 Values	df	*p*-Values
Age	192.583	28	0.000
Gender	6.059	4	0.195
Education level	210.153	20	0.000
Marital status	140.074	12	0.000
Employment status	69.608	4	0.000
Income level	214.429	28	0.000
Mode of transportation	26.312	12	0.010
Car ownership	5.094	4	0.278

Note: $p \leq 0.05$, df = degree of freedom.

5.3.3. Relationships between Efficient Parking Pricing Preferences and Sociodemographic Characteristics

The results of the Chi-square (χ^2) test, illustrated in Table 7, reveal a significant association between efficient parking pricing preferences and various sociodemographic characteristics. Specifically, the analysis demonstrated significant associations with age (χ^2 = 184.112, *p*-value = 0.000), education level (χ^2 = 268.108, *p*-value = 0.000), marital status

(χ^2 = 60.753, *p*-value = 0.000), employment status (χ^2 = 37.338, *p*-value = 0.000), income level (χ^2 = 324.178, *p*-value = 0.001), mode of transport (χ^2 = 44.903, *p*-value = 0.000), gender (χ^2 = 14.419, *p*-value = 0.006), and car ownership (χ^2 = 18.748, *p*-value = 0.001). These findings suggest that various sociodemographic factors significantly influence preferences for efficient parking pricing.

Table 7. Chi-square test for the relationship between efficient parking pricing preference and sociodemographic characteristics.

Sociodemographic Variables	**X^2 Values**	**df**	***p*-Values**
Age	194.112	28	0.000
Gender	14.419	4	0.006
Education level	268.108	20	0.000
Marital status	60.753	12	0.000
Employment status	37.338	4	0.000
Income level	324.178	28	0.000
Mode of transportation	44.903	12	0.000
Car ownership	18.748	4	0.001

Note: $p \leq 0.05$, df = degree of freedom.

5.3.4. Relationships between Preferences for Increased Fuel and Road Taxes on Private Vehicles and Sociodemographic Characteristics

The Chi-square (χ^2) test results, depicted in Table 8, indicate a notable correlation between the preference for increased fuel and road taxes on private vehicles and diverse sociodemographic characteristics. Specifically, the analysis revealed substantial correlations with age (χ^2 = 234.238, *p*-value = 0.000), education level (χ^2 = 267.757, *p*-value = 0.000), marital status (χ^2 = 78.657, *p*-value = 0.000), employment status (χ^2 = 22.744, *p*-value = 0.000), income level (χ^2 = 235.613, *p*-value = 0.000), mode of transport (χ^2 = 63.304, *p*-value = 0.000), gender (χ^2 = 9.818, *p*-value = 0.044), and car ownership (χ^2 = 30.345, *p*-value = 0.000). These results suggest that a range of sociodemographic factors significantly impact preferences regarding increased fuel and road taxes on private vehicles.

Table 8. Chi-square test for the relationship between preferences for increased fuel and road tax on private vehicles and sociodemographic characteristics.

Sociodemographic Variables	**X^2 Values**	**df**	***p*-Values**
Age	234.238	28	0.000
Gender	9.818	4	0.044
Education level	267.757	20	0.000
Marital status	78.657	12	0.000
Employment status	22.744	4	0.000
Income level	235.613	28	0.000
Mode of transportation	63.304	12	0.000
Car ownership	30.345	4	0.000

Note: $p \leq 0.05$, df = degree of freedom.

6. Discussion

Travel demand management strategies are designed to reduce the demand for private vehicle travel and encourage the use of alternative modes of transportation. These strategies aim to alleviate traffic congestion, reduce air pollution, conserve energy, and improve overall transportation efficiency. The preference for various TDM strategies was estimated using RII ranking. The respondents ranked mass transit improvements as the most preferred TDM strategy. This outcome was expected given that public transport is one of the most direct methods for reducing congestion when implemented correctly [41]. Road users' preferences for mass transit improvements can be attributed to several factors, including cost, convenience, and familiarity with the strategy. Improvements in mass transit systems may offer financial incentives, such as reduced fares or improved cost efficiency, attracting respondents seeking economic benefits. These findings support those of a study conducted by Bhattacharjee et al. [13] in Bangkok. Weisbrod et al. [42] provide a comprehensive summary of the benefits associated with public transit, which can be categorized into two major groups. First, mobility benefits arise from increased travel opportunities for individuals who face economic, physical, or social disadvantages. Second, efficiency benefits stem from the decrease in vehicle traffic resulting from the transition from inefficient automobile travel to more efficient transit travel. Moreover, it is worth noting that the improvement of mass transit services has been shown to result in a significant increase of 20 to 50% in affected transit travel, which is accompanied by a reduction of 5 to 15% (and occasionally more) in automobile travel [43]. Curitiba, the capital of Paraná in Brazil, has developed a high-quality, cost-effective public transport system over the past 30 years. Today, it is internationally recognized as a model for urban planning. Through insightful long-term planning and innovative solutions, Curitiba has created an effective system that prioritizes public transportation over private vehicles, benefiting its citizens significantly [44,45]. The city of Paris has also implemented many sustainable transportation policies. During the last two decades, it has improved its public transit services [38,46].

The second most preferred strategy was walking and cycling improvement. This approach is a predictable choice given the sustainability, lower costs, and associated health and social advantages of these modes [47]. This indicates a significant preference for initiatives that promote active modes of transportation and highlights the importance of Ghana investing in infrastructure and policies that facilitate walking and cycling. This suggests that if walking and cycling infrastructure and facilities are provided and improved in Ghana, then road users will highly prioritize them, potentially reducing private vehicle usage and associated congestion. Zhou et al. [48] recognized that providing well-designed non-motorized transport (NMT) facilities effectively promotes bicycle usage, leading to improved physical health. The promotion of active modes of transportation such as walking and cycling can contribute to various benefits, including improved health, reduced congestion, and decreased environmental impact [49]. Communities centered on walking, cycling, and public transportation offer more than just environmental and health benefits; they also yield substantial cost savings for their inhabitants [50]. Improved walking and bicycling conditions tend to increase non-motorized and transit travel as well as reduce automobile travel [51,52]. Portland, Oregon has introduced public and private micro-mobility services, including shared e-scooters, in the downtown core. According to the Portland Bureau of Transportation (PBOT), these bike-share and scooter-share programs have the potential to reduce carbon emissions to 50% of 1990 levels. PBOT anticipates that these programs will increase micro-mobility usage from 7% of all trips in 2019 to 25% by 2035 [53]. Boulder, Colorado also made significant investments in walking, cycling, and public transit, resulting in a reduction in single-occupancy vehicle (SOV) mode share [54].

Respondents also believe that alternative work schedules and staggered school and work hours can help reduce the number of employees arriving and leaving a worksite at a time. These strategies were ranked third and fourth with RIIs of 0.872 and 0.852, respectively. The rationale behind these strategies lies in their potential to optimize travel demand. By introducing alternative work schedules and staggered hours, the goal is to mitigate peak-hour congestion and enhance the efficiency of travel patterns. This approach aligns with the idea of spreading commuting times, preventing concentrated rushes of employees traveling to and from work simultaneously. The implementation of alternative work schedules and staggered hours is seen as a practical solution for alleviating traffic congestion during peak periods. This perspective is reinforced by insights from the Victoria Transport Policy Institute (VTPI) [40], which suggested that these strategies can positively impact traffic management and contribute to a more balanced and streamlined flow of commuter traffic.

According to the preference ranking list of the TDM strategy, the least favored approaches were efficient parking pricing, congestion pricing, and increased fuel and road taxes on private vehicles. This outcome is expected, as these strategies involve introducing additional costs for travel, inconvenience, and unreliable public transportation, which respondents generally oppose. In various studies, strategies like road pricing and parking charges have been perceived as less acceptable by the public compared to improvements in public transportation [13,15,55]. Nilsson et al. [56] found that some individuals perceive congestion pricing as a violation of personal freedom, leading to low support for such measures. Consequently, the limited adoption of congestion pricing initiatives is attributed to the lack of public support [57]. Bhattacharjee et al. [13] also reported that increased parking fees in government offices were the least favorable response of respondents. Despite potential benefits such as direct funding for roads, parking, and related expenses, road users tend to resist any price increases, viewing them negatively. This resistance poses a significant obstacle to the implementation of pricing reforms [58]. Steg and Vlek [59] stated that commuters normally perceive pull measures to be more suitable, even though push measures are often estimated to influence car use decrease largely. Congestion pricing has proven to be a highly effective strategy in London, serving as a model for other major cities considering similar systems. This approach charges specific vehicles a flat fee to use public roads, thereby incentivizing reduced car use. Exemptions apply to certain vehicles, including those using alternative fuels, vehicles for disabled citizens, taxis, and motorcycles. The program successfully decreased the number of car trips into central London, reduced congestion-related delays for buses, and alleviated overall traffic congestion [60].

Regarding the demographics of the participants, a Chi-square test of association was conducted to explore whether there was a noteworthy connection between sociodemographic factors and specific TDM strategies. A significance level of $\alpha \leq 0.05$ was used to determine the presence of a significant association. The test of the association between mass transit improvement preference and sociodemographic characteristics of gender and car ownership revealed non-significant values. Age, level of education, marital status, employment status, income, and mode of transport were also found to be significant. This means that mass transit improvement preference had no association with gender or car ownership. The study indicated that age differences influence preferences for mass transit improvement strategies. It reveals that older individuals are more likely than younger individuals to favor these strategies due to differing priorities, resulting in diverse mobility needs and comfort requirements. Additionally, the study suggests that individuals with higher education levels are more likely to prefer mass transit improvements than those with lower education levels, which is likely due to greater awareness of environmental issues and the benefits of public transportation. Single individuals are also more inclined to support mass transit improvements compared to married individuals due to varying responsibilities. Similarly, unemployed individuals may prioritize mass transit strategies that enhance their daily commutes, such as increased reliability and frequency of services, more than employed individuals. Furthermore, lower-income individuals are more likely to favor mass transit improvements compared to higher-income individuals due to their differing financial situations. Finally, the choice of transport mode also affects preferences for mass transit improvement strategies. Regular users of mass transit are more likely to prefer a mass transit improvement strategy compared to those who use it less frequently. The research also indicates that preferences for mass transit improvements are comparable among both men and women, suggesting that initiatives can be universally designed without specific gender considerations. Additionally, individuals who own cars and those who do not exhibit similar preferences for mass transit enhancements, underscoring their perceived universal benefits irrespective of current transportation preferences. These findings align with numerous existing studies demonstrating that socioeconomic factors significantly influence the selection of TDM strategies [12–14].

Additionally, unlike gender and car ownership, which were found to be statistically insignificant, a statistically significant association was found between walking and cycling improvement preferences and age, level of education, marital status, employment status, income, and mode of transport. Consequently, the preferences of males and females as well as car owners and non-car owners regarding walking and cycling improvements do not differ significantly. The results revealed different age groups may have varying levels of interest in walking and cycling improvements due to physical ability, lifestyle, and health considerations. Older adults might prioritize safer and more accessible pathways, while younger individuals might seek more efficient and faster routes. Moreover, higher levels of education might correlate with a greater awareness of health benefits and environmental impacts, leading to stronger preferences for walking and cycling improvements. Additionally, single individuals might have different mobility needs and preferences compared to married individuals or those with children, which can affect their interest in walking and cycling infrastructure. Moreover, employed individuals, especially those who commute, might prioritize improvements that make walking and cycling viable alternatives to driving or public transport. Income levels can influence transportation choices and preferences; higher-income individuals might have more flexibility in their transportation choices, while lower-income individuals might rely more on walking and cycling as cost-effective options. Finally, transportation habits can shape preferences; those who already walk, or cycle are likely to support improvements, whereas those who drive might not see the same level of benefit. The findings also suggest that walking and cycling improvements are broadly supported across different genders and car ownership statuses, potentially facilitating a wider acceptance and implementation of such projects. These findings corroborate numerous existing studies indicating that socioeconomic factors significantly impact the selection of TDM strategies [12–14].

Furthermore, the analysis of the effect of efficient parking pricing preferences and increased fuel and road taxes on private vehicle preferences revealed statistically significant associations across all demographic factors, including gender, car ownership, age, level of education, marital status, employment status, income, and mode of transport. This suggests that there are significant differences in how men and women perceive transportation costs and convenience. Moreover, these differences influence their support for related policies. Men and women often weigh policies based on their perceived fairness and the impact on their daily routines. Owning a car directly impacts personal finances due to increased taxes and fuel fees. Consequently, this might lead to resistance to policies that raise these costs; however, for non-car owners, this might lead to acceptance of the strategy. Also, generational disparities influence attitudes toward transportation policies. Older individuals are generally more environmentally conscious and supportive of green initiatives, while younger generations tend to prioritize cost-effectiveness over environmental concerns. Higher levels of education often correlate with greater awareness of the environmental and economic impacts of transportation, leading to stronger support for environmentally friendly policies among more educated individuals. Additionally, there are distinct transportation needs and financial considerations between married individuals and singles. Married individuals might prioritize factors such as cost and convenience when evaluating transportation policies, whereas singles often focus more on their personal mobility needs. Additionally, commuting requirements and financial stability differ based on employment status; unemployed or part-time workers may be especially sensitive to transportation cost increases. Income levels also play a crucial role in the ability to manage higher transportation costs; while higher-income individuals may be less impacted, they still consider fairness and efficiency when supporting related policies. This aims to enhance convenience and sustainability in urban mobility. These findings support existing studies that revealed socioeconomic factors significantly influence the choice of TDM strategies [12–14]. The influence of demographic factors is pivotal in determining the efficacy of TDM strategies. Therefore, tailoring TDM strategies to match the demographic profile of a specific region enhances the likelihood of successful implementation and widespread acceptance.

7. Implications of Findings

The implications of these findings for policy and practice are significant and can inform targeted interventions aimed at reducing traffic congestion and promoting sustainable transportation methods. The study has the following potential policy and practice implications:

1. Investment in mass transit infrastructure

Given that mass transit improvements have emerged as the most preferred strategy, policymakers should prioritize investments in enhancing public transportation systems. This could involve expanding the existing infrastructure, improving service frequency and reliability, and implementing measures to make public transit more attractive, accessible, and convenient for commuters. Policymakers should develop policies that ensure strict adherence to bus schedules and comfortable vehicles and provide robust regulatory support. These policies can focus on monitoring and managing bus schedules rigorously to guarantee reliability and punctuality. Additionally, they should implement regulations that support bus priority measures and enforce traffic laws to keep bus lanes clear. By addressing these areas through comprehensive and well-thought-out policies, policymakers can significantly enhance the quality and reliability of mass transit bus services, leading to increased public usage, reduced traffic congestion, and improved environmental outcomes.

2. Promotion of active transportation

The popularity of walking and cycling improvements suggests a growing interest in active transportation modes. Policymakers can promote walking and cycling by investing in infrastructure such as bike lanes, pedestrian pathways, and sidewalks. Additionally, public awareness campaigns can be launched to encourage individuals to choose walking or cycling for short trips instead of relying on motor vehicles. Policymakers should develop policies that designate specific areas, such as Central Business Districts (CBDs), as car-free or low-emission zones. By implementing car restriction measures, the policy seeks to promote the use of public transportation, cycling, and walking, enhancing the overall quality of life for residents.

3. Support for alternative work schedules

The preference for alternative work schedules indicates a willingness among individuals to adopt flexible work arrangements. Policymakers can work with employers to promote initiatives such as telecommuting, flexible hours, and compressed workweeks. These measures not only reduce congestion during peak hours but also offer benefits such as improved work–life balance and reduced stress for employees. Policymakers should develop and implement policies that support alternative work schedules. These policies should include flexible work hours, remote work options, and compressed workweeks to accommodate diverse workforce needs and promote work–life balance. By endorsing such measures, policymakers can help reduce commuting time and costs, lower stress levels among employees, and increase overall productivity.

4. Implementation of staggered schooling and work hours

Staggering schooling and working hours can help alleviate congestion by spreading out peak travel times. Policymakers can collaborate with educational institutions and employers to implement staggered schedules where feasible. This could involve adjusting school start times, offering flexible arrival and departure times for employees, and coordinating transportation services to accommodate varied schedules. Policymakers should develop and implement policies that support the adoption of staggered schooling and work hours. This approach involves adjusting the start and end times for schools and workplaces to reduce congestion during peak hours, leading to numerous societal benefits. To implement such policies effectively, a coordinated effort is necessary. Policymakers should collaborate with local governments, transportation authorities, educational institutions, and businesses to create a framework that supports staggered hours.

5. Considering sociodemographic disparities

The significant correlations between demographic variables such as age, education level, marital status, income level, and transportation preferences highlight the need to consider socioeconomic factors in transportation planning. Policymakers should ensure that TDM strategies are equitable and accessible to all segments of the population. This may involve targeted outreach and support for disadvantaged communities, subsidies for low-income individuals to access public transit, and initiatives to improve transportation options in underserved areas.

8. Conclusions

This paper sought to assess road users' understanding of and willingness to adopt various TDM strategies in Accra, Ghana. This study provides insights for policymakers aiming to enhance the sustainability, efficiency, and equity of transportation systems through travel demand management strategies.

The study findings showed a strong preference for strategies focusing on improving mass transit, promoting walking and cycling, and implementing alternative work schedules. These strategies were regarded favorably due to their potential to enhance efficiency and accessibility and reduce private vehicle usage and congestion. On the other hand, strategies such as efficient parking pricing, congestion pricing, and increased fuel and road taxes on private vehicles were ranked in the bottom three as they received lower preference levels. Furthermore, the Chi-square test results revealed that there was a significant relationship between all the selected TDM strategies and factors such as age, education level, marital status, income level, and mode of transportation. However, it was observed that gender and car ownership did not exhibit a significant relationship with any of the selected TDM preferences. The findings underscore the importance of considering demographic factors in the development and implementation of TDM strategies. Tailoring these strategies to align with the demographic profile of a specific region increases the likelihood of successful implementation and widespread acceptance. This nuanced understanding of how different demographic groups respond to various TDM measures can inform more targeted and effective transportation policies and practices.

To address urban transportation challenges, policymakers should focus on a multi-faceted approach. Compared with the traditional approach of building/expanding roads, TDM provides a viable solution for addressing congestion. Given the high preference for mass transit improvement in the survey results, it is recommended that Ghana's Ministry of Transport, Ghanaian joint state, and privately owned transport companies such as the State Transport Corporation (STC), Omnibus Service Authority (OSA), City Express Services (CES), Metro Mass Transit (MMT), and Ghana Private Road Transport Unions (GPRTU) should prioritize investments in enhancing public transportation systems in Accra. This may involve improving existing modes of public transit, such as buses and trains, and expanding the network to cover more areas of the city of Accra. Additionally, stakeholders should ensure that efforts are made to increase efficiency and accessibility, including through the use of reliable schedules, comfortable vehicles, and affordable fares. Promoting active transportation, such as walking and cycling, requires investment in infrastructure like bike lanes and sidewalks along with car-free zones in key areas. Supporting alternative work schedules through telecommuting, flexible hours, and compressed workweeks can reduce peak hour congestion and improve work–life balance. Implementing staggered schooling and work hours can further alleviate congestion by spreading out travel times, necessitating collaboration with educational institutions and employers. Additionally, addressing sociodemographic disparities in transportation planning ensures equitable access for all populations, involving targeted outreach, subsidies for low-income individuals, and improved options in underserved areas. Together, these strategies can create a more efficient, inclusive, and sustainable transportation system.

9. Limitations of the Study and Future Research

This study also had some limitations. Firstly, the research was constrained by its focus on a singular metropolis, and considering Ghana's expansive size and diverse ethnic communities, variations in TDM strategies preference across different regions of the country may exist. Therefore, generalizing the findings of this study to other cities or entire nation could be challenging due to these potential regional differences. Secondly, this study focused on the relationship between demographic factors such as age, gender, education level, marital status, employment status, income level, mode of transportation, and car ownership and strategy preferences. Other factors that may have significant influences, such as family structure, behavior patterns, psychological factors, etc., were not considered for this study. For this reason, future studies have been proposed to address the preference for TDM strategies across different cities and to consider behavior patterns and psychological factors.

Considering the outcomes of this study and limitations, future research can assess the economic and financial implications of implementing TDM strategies in Accra. Future research should also investigate TDM strategy preferences across various regions of the country. This will help determine if the findings are consistent nationwide or if there is a correlation between preferences and the specific characteristics of the demographics of the road users surveyed. Additionally, further studies should consider exploring a wider array of socioeconomic and psychological factors that may influence the preference for TDM strategies in Accra, Ghana. Also, comparative analyses of preferences and responses to TDM strategies across various groups and regions would be valuable. Evaluating the comprehensive effects of different strategy combinations should also be considered. This would provide valuable insights into the feasibility and cost-effectiveness of these strategies, helping policymakers and urban planners make informed decisions. Thus, the formulation of policies that align with the preferences and constraints of different user groups.

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