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Market segmentation for incentivising sustainable transport policies

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ABSTRACT

This paper draws attention to the need for formulating tailored, sustainable transport policies considering heterogeneity in the population regarding their preferences and attitudes. In this regard, we propose a market segmentation for incentivising sustainable transport policies. Our analysis builds from the responses of 1,041 car owners towards environmentally friendly transport alternatives in a survey issued in the five largest Colombian metropolitan areas: Bogotá, Medellín, Cali, Barranquilla, and Bucaramanga. Using the collected data, we estimated a Multiple Indicators Multiple Causes (MIMIC) model to evaluate individual attitudes towards the environment, green transport policies, car use, and technology. A cluster analysis based on the MIMIC results identified three groups: *Traditionalists, Green Conscious* and *All Matters*. Results make the contradiction between car attachment and environmental concern evident. The lower the environmental concern, the higher the attachment to the car. However, the differences between *Traditionalists* and *All Matters* are less pronounced. Finally, we proposed sustainable strategies considering the heterogeneities of each group, analysed the implications of developing custom-made actions and marketing strategies for promoting sustainable transport policies, considering the interests and characteristics of each targeted group in the population.

1. Introduction

In recent years, there has been an increasing trend in promoting sustainable transport in which the primary goal is to reduce transport-related externalities. A key concern is reducing greenhouse gas emissions and air pollution produced by the transport sector, responsible for 23% of world CO_2 emissions (IEA, 2014). For that matter, different travel demand management techniques have been tested (Loukopoulos et al., 2004), including congestion charging, parking management policies, car use restrictions, and alternative fuel vehicle incentives. Other sustainable policies are the promotion of public transport (van Malderen et al., 2012; Bueno et al., 2017; Rye, 1999), carpooling (van Malderen et al., 2012; Neoh et al., 2017), walking (Larrañaga et al., 2016a; 2018; Arellana et al., 2021a) and cycling (van Malderen et al., 2012; Gutierrez et al., 2021). Each policy tries to tackle various externalities related to transport, primarily looking to decrease car dependency, congestion, and pollution (Guzman et al., 2020).

However, when people use their cars, they mostly perceive the private cost related to their use. They do not account for the generally negative implications that they are causing to society. Recently, Andor et al. (2020) showed that car owners vastly underestimate the cost of owning a car, which makes incentivising sustainable policies among car users a non-trivial task. It deserves an

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in-depth study of the target market, focusing on individual preferences toward policies and new technologies, identifying the essential attributes users consider and knowing how they can be segmented. These would be helpful tools for making segment-specific campaigns and programs that could have better acceptance to help the process.

This paper analyses the Colombian case by using an attitudinal survey applied in the five largest cities: Bogotá, Medellín, Cali, Barranquilla and Bucaramanga. The vehicle ownership rate at the country level is nearly 110 cars per 1000 inhabitants (Ministerio de Transporte, 2020). That figure is small compared to high-income countries, which may result from the perception of the automobile as a symbol of high social status or an aspirational good in Global South countries. Nevertheless, the vehicle market has been growing steadily by about 5% on average in the last decade, increasing congestion and externalities in Colombian cities. Car ownership is associated with high-income sectors, which have a strong influence on government decisions and media.

This analysis focuses on car owners considering that most sustainable transport policies aim to modal shift from traditional private vehicles towards other environmentally friendly alternatives, such as bus, bicycle, and walking (Thaller et al., 2021). Using structural equation modelling, we collected data to evaluate environmental concerns, attitudes towards car use, and technology. Then, we performed a cluster analysis to generate market segments and characterise them. The primary purpose was to determine which types of drivers are willing to change their mode of transport. Another goal is to derive possible policies and strategies that encourage sustainable transport policies such as cycling (Gutierrez et al., 2021), walking (Arellana et al., 2020a) and promoting AFV (Soto et al., 2018b), considering those differences within the population and what types of changes individuals would be willing to consider, given the cluster's socioeconomic and car ownership profile.

The paper organisation is as follows: Section 2 is the literature review; Section 3 provides information about the data used; Section 4 shows the model framework. The estimated results are given and analysed in Section 5. Finally, Section 6 presents the conclusions.

2. Literature review

The promotion of sustainable transport policies entails several challenges. Most of them are related to reluctance to changes from some sectors that feel affected by the measures and the unwillingness of decision-makers to face the political costs of implementing unpopular policies (Ortúzar et al., 2021). For example, critical barriers to promoting alternative fuelled vehicles (AFVs) are public awareness and acceptability of these new technologies. Humans are frequently reluctant to change (Cantillo et al., 2007) and are resistant to new technology considered unfamiliar or unproven. Innovativeness is a psychological construct that allows user identification (Morton et al., 2016) to accept changes; however, inertia can be hard to overcome (Valeri and Cherchi, 2016). Thus, raising awareness, acceptance and trust among vehicle consumers is one of the primary fields to increase AFV demand (Egbue, 2012; von Rosenstiel et al., 2015).

Overcoming car dependence to promote public transport has been another challenge to achieving sustainability. To that end, car restricting policies, subsidies and parking management policies have been proposed (Guzman et al., 2020; Toro-González et al., 2020; Orozco-Fontalvo et al., 2020; Soto et al., 2018a). In that sense, the application of congestion charging has been widely accepted among academics as a measure in which the drivers are charged for the externalities they produce. These "revenues" can be invested in public spaces or in improving public transport networks. However, the principal obstacle for congestion charging implementation has been the lack of acceptance by the general public (Grisolia et al., 2015), as people might see the measure as a new and regressive tax (Levinson, 2010) and have a lack of confidence in how the resulting revenue will be used (Kim et al., 2013).

The congestion charging policy in Latin American cities faces several challenges related to citizen acceptance and the necessary political support for its implementation. Some individuals argue that this policy favours the richer (who can pay) and is, therefore, regressive. Others claim that users should not be charged for a public good that has always been free. A broad discussion in this regard is carried out by Ortúzar et al. (2021). In Colombia, congestion charging has not been implemented as decision-makers and politicians will not enforce policies that could turn potential voters against them. A congestion charging scheme has not progressed beyond conceptual viability studies (Ramos et al., 2017). This measure has been included in the last three National Development Plans (2010–2014, 2014–2018 and 2018–2022), which gives the cities a regulatory framework to implement it autonomously and allocate resources from congestion charging to BRT operation (FDN, 2019; Bocarejo, 2020). However, only two cities have studied its implementation, Bogota and Medellin. Medellin has studied the congestion charge policy but has not proposed it to the city council for approval. In turn, Bogota has presented the policy project to the city council three times, all of which were rejected (FDN, 2019; Bocarejo, 2020).

Instead, several major Colombian cities have applied a car restricting policy for addressing congestion based on license plate number, limiting car circulation one (or more) day per week according to the last digit of its plate. It is an example of a transport policy that has been successfully promoted as an effective measure to address congestion and pollution despite initial opposition from some sectors. This policy's acceptance levels are high despite existing evidence that it is not effective (Bonilla, 2019; Cantillo and Ortuzar, 2014). When promoting the measure, authorities used different marketing strategies to gain support, including focalised advertisements. Over the last few years, some Colombian cities have implemented a daily pass measure that allows drivers to pay to use their cars during restricted days. This measure has not been exempted from user backslash, but it seems to be more easily implemented than proper congestion charges (Montero et al., 2018).

The promotion of active transport modes such as walking and cycling are among the most popular sustainable transport policies worldwide. However, planning appropriate infrastructures and promoting their use in the Global South countries face several challenges (Gutiérrez et al., 2021; Arellana et al., 2021a). Despite having a high development of public transport solutions in recent years, Latin American cities have tended to prioritise investments that favour car use (Arellana et al., 2021a). Indeed, car owners tend to correspond to higher-income sectors and have a strong influence on public policy. Car owners often oppose projects involving giving up part of the public space to active mobility or the public transport system if this implies reducing space for cars. These users consider that paying taxes is equivalent to buying the space to move around the city (Guzman et al., 2021). An example of this challenge was the opposition of car users to the provision of bicycle lanes during the Covid-19 pandemic in Bogotá and other Colombian cities (Arellana et al., 2020d).

In consequence, promoting the use of active transport modes require a better understanding of both the factors enabling walking (Arellana et al., 2020a; Larrañaga et al., 2016a,b) and cycling (Arellana et al., 2020b) as well as barriers to them (Larrañaga et al., 2018), determined by the user and non-user perceptions and local conditions (Iwińska et al., 2018; Nkurunziza et al., 2012; Cantillo et al., 2015). Increasing active transport requires addressing various social and physical barriers beforehand (Mosquera et al., 2012). Additionally, policy proposals that promote cycling usually have broad support. However, when biking infrastructure competes with space for pedestrians and cars, backing will decline.

As the feasibility of transport policies seems to rely on social acceptability to be implemented or to be widely used and to avoid political backlash, it is strongly needed to understand individual behaviour, characteristics, perceptions and attitudes towards such policies (Amaya et al. 2020; Arellana et al., 2021b). Following this premise, several studies evaluate individual attitudes and preferences towards transport policies, considering the effect of environmental concern (Bolduc et al., 2008; Daziano and Bolduc, 2013; Jensen et al., 2013; Soto et al., 2014; Soto et al., 2018b; Márquez et al., 2019); safety (Daziano, 2012; Soto et al., 2018a); convenience and vehicle lease (Glerum et al., 2013); appreciation of car features (Mabit et al., 2015); pro-car and pro-technology attitudes (Soto et al., 2018b; Cantillo et al., 2019); security (Marquez and Soto, 2021); social influences (Kim et al., 2014), comfort and reliability (Ramos et al., 2017), and habitual behaviour (Valeri and Cherchi, 2016).

Environmental concern has proven to be significant in several contexts, including the willingness to use a bicycle (Cantillo et al., 2019), mode choice (Rieser-Schüssler and Axhausen, 2012; Roberts et al., 2018), inter-urban transport (Bahamonde-Birke et al., 2015) and AFV purchase (Jensen et al., 2013), among others. Indicators associated with the appreciation of car features are significant in contexts like willingness to use a bicycle (Cantillo et al., 2019; Gutierrez et al., 2021), mode use (Hess et al., 2018; Şimşekoğlu et al., 2015) and car purchase (Bolduc et al., 2008; Jensen et al., 2013).

In the context of AFV purchase, Soto et al. (2018b) suggest considering several attitudes together instead of the isolated effect of a particular one on individual behaviour. The above was concluded because the authors found that technology-related attitudes influenced environmental concerns and pro-car behaviour attitudes (Soto et al., 2018b). Indeed, they found that changes in respondents' attitudes related to environmental concern, attitudes towards car use, and support for sustainable policies led to changes in AFV demand and preferences towards conventional vehicles, but at the population level. Then, the authors also recognise the need to incorporate individual heterogeneity in the policy acceptance and demand analyses, as personal characteristics, individual perceptions and attitudes towards car use, and sustainable policies play an essential role in their behaviour.

The purpose of market segmentation is to divide the potential market into groups based on different characteristics. As each identified segment shares similar characteristics, marketing strategies are designed in accordance. Segmenting the market by differentiating target groups is a strategy that can be useful when promoting transport policies. Market segmentation has been carried out in different contexts like travel behaviour (Anable, 2005); freight shipper mode choice (Arunotayanun and Polak, 2011); shopping channel (Mokhtarian et al., 2009); bicycle commuting (Li et al., 2013); shared parking (Zhang et al., 2018); public transport ridership (Shiftan et al., 2008), and commuting (Ye et al., 2018) among others. Market segmentation has been used in sustainable policies in the contexts of tourism (Dallen, 2007), travel behaviour (Anable, 2005; Prillwitz and Barr, 2011) and environmental measures (Poortinga and Darnton, 2016). Studies that aim at identifying population segments to promote sustainable transport policies in Latin American countries have not been conducted to our best knowledge.

Nevertheless, the high levels of informality in urban transport (Cervero and Golub, 2007; Hernández and Dávila, 2016) in Latin America might be one of the reasons for the absence of studies looking at identifying population segments to promote sustainable transport policies in the region. Among the scarce studies focusing on market segmentation in the context of informal transport services in the Global South stand out those conducted by Tarigan et al. (2014) in Indonesia, Klopp and Cavoli (2019) in African cities, and Shaw and Pandit (2001) in India.

3. Modelling approach

An appropriate statistical approach is necessary to manage the data. We used exploratory factor analysis to identify the relationship of the indicator variables with the constructs that allowed us to reduce the dimensionality of variables by discarding non-significant indicators. Then, we proposed a confirmatory approach using a Multiple Indicators Multiple Causes (MIMIC) model (Bollen, 1989). The MIMIC model has two parts: the structural equations and the measurement equations. The structural equations are the ones that relate the socioeconomic characteristics with the latent variables; on the other hand, the measurement equations are the ones that relate the indicators with the latent variables.

Socioeconomic variables explain the latent variables in the MIMIC model through the structural equations, and latent variables explain the indicators through measurement equations. The structural equations are given by equation (1), while the measurement equations can be estimated as (2).

$$X_l^* = \sum_r \gamma_{rl} S_r + \delta_l \tag{1}$$

$$I_m^* = \sum_l d_{lm} X_l^* + \vartheta_m \quad (2)$$

Where X_l* is the latent variable l, S_r is the socioeconomic variable r, I_m^* is the continuous indicator m. γ_{rl} and d_{lm} are parameters to be estimated, while δ_l and ω_m are error terms with means equal to 0 and the standard deviation to be calculated. Recognising the ordered nature of the observed indicators, the measurement equations were specified as ordered probit models. Table 1 shows the variables used.

After that, we segmented and profiled the respondents for marketing purposes (Jansson et al., 2009; Nilsson, 2009). We used the predicted values of the latent variables for each respondent and performed a cluster analysis using the K-means procedure (Zeybek, 2018). This approach is distance-based among observations and the cluster's centroids, assigning an observation to the nearest centroid, which is recalculated based on the mean of all observations belonging to the cluster (Hair et al., 1998). This process is done iteratively until the assignments stop changing. After finding the solution, we profiled the clusters regarding their attitudes and socioeconomics. Then, we validated the clusters using an ANOVA for evaluating differences among them. Finally, we gave names to each profile according to the results.

4. Data

The investigation data comes from a survey applied in the five most populous Colombian metropolitan areas (Bogotá, Cali, Medellin, Barranquilla and Bucaramanga), which combined almost 70% of total vehicles in the country. The survey was applied only to vehicle owners, given that they are considered the users with the highest inertia to modal shift when new and sustainable options are available (Gonzalez et al., 2017). We collected 1,041 valid questionnaires out of 1,200 for an 89% response rate. From Bogotá and Bucaramanga, we obtained 200 responses per city, Medellin 196, Cali 219, and Barranquilla had the remaining 226 responses.

Table 2 presents a brief city profile. Bogota, the country's capital, is the most populated urban conurbation. Medellín and Cali are large cities of intermediate size, while Barranquilla and Bucaramanga are the least populated. Although there are no major differences in motorisation rates among principal cities, Bogotá, the capital of Colombia, has the highest rate per 1000 inhabitants (154). The motorisation rates in Bucaramanga, Cali and Medellin are very similar (138, 136, and 133, respectively). With 110 vehicles per 1000 inhabitants, Barranquilla has the lowest motorisation rate among principal cities (Ministerio de Transporte, 2020). The modal split in all cities reveals that public transport continues to prevail in large Colombian cities. However, the participation of active modes, mainly walking, is relevant. The high participation of motorcycles and informal modes is also remarkable. Regarding income, Barranquilla has the lowest income per capita, while Bogotá and Bucaramanga have the highest.

We selected as explanatory variables individual characteristics following previous studies (Mokhtarian et al., 2009, Cao et al., 2012; Jansson et al., 2017a). They include sociodemographic, social and psychological characteristics, attitudes, perceptions and consumer preferences. These variables allow for delineating distinct market segments.

The questionnaire of the face-to-face survey, applied to randomly selected vehicle owners or frequent drivers, included the following sections:

Socioeconomics: City, gender, age, number of household members, number of vehicles, number of motorcycles, employment, educational level, income and socioeconomic stratum[1] (Cantillo-Garcia et al., 2019).

Vehicle characteristics: Fuel type, capital cost, vehicle type and engine size.

Perception indicators: The survey involved a questionnaire of perception indicators. It included 23 indicators related to green transport policies, environmental concerns, and car use and technology attitudes. Respondents rated some statements on a 1 to 5 Likert scale.

Two out of every three of the interviewees were men, according to the information presented in Table 3. This gender gap is not surprising as men hold 74% of driver's licenses in Colombia. Furthermore, most of the respondents are working people and students with a university education or higher. Almost all the respondents belong to the middle and upper social classes. This phenomenon is easily explained by the fact that the survey's target population were car owners. In Colombia, a vehicle is not easily affordable for low-income users, and the most popular choice is small vehicles, as presented in the survey results.

Regarding vehicle information (Table 4), most of the respondents' current vehicles were automobiles, while 26% were utility vehicles (UV). This finding is in line with the Colombian vehicle fleet, in which the UV represents one of every three private vehicles. Finally, gasoline represents almost 90% of the sample, leaving diesel with 8.3% and NGV with 3.4%.

After collecting socioeconomic and vehicle ownership information, we asked about the respondent agreement level with a series of indicators. First were the indicators related to transport policies. The level of support for or opposition to transport policies has proven to be significant for the environmental concern and choice when purchasing alternative fuel vehicles (Bolduc et al., 2008; Soto et al., 2018b; Daziano and Bolduc, 2013). Also, the perceived appropriateness of the policy appears to be a relevant factor in recognising the level of appraisal of a proposed measure (Saleh et al., 2019). The first group of indicators (1 to 6) were organised in pairs to consider the degree of acceptance for one policy against the other. The pairs of statements were those indicated in Table 5. A rating of 5 means a more definite preference for the right alternative, while a score of 1 means the opposite.

[1] In Colombia a stratified household categorization is used to assign subsidies, calculate household taxes and public services tariffs. It classifies households from 1 to 6, 1 being the lowest socio-economic stratum and 6 the highest . We define the household low social class if it belongs to stratum 1 or 2, medium social class if it belongs to stratum 3 or 4 and high social class if it belongs to stratum 5 or 6.

Table 1
Variables used in the MIMIC model.

Used in	Variable	Type	Description
Measurement equations	I_m	Categorical	Indicator *m*
	d_{lm}	Continuous	Regression weight of latent variable *l* for indicator *m*
Structural equations	Vehipers	Continuous	Number of cars/Number of household members
	Age25	Dummy	Respondent's age (1: If age is<25, 0 otherwise)
	Age40	Dummy	Respondent's age (1: If age is between 25 and 40, 0 otherwise)
	Engine	Dummy	Engine size (1: If the engine size is>2.4 L, 0 otherwise)
	EdLevel	Dummy	College or higher dummy (1: if the educational level is college, 0: otherwise
	Gender	Dummy	Female dummy
	HighClass	Dummy	1: If the person belongs to the high-socioeconomic strata (stratum 5 or 6), 0 otherwise
	LowCost	Dummy	1: If the current vehicle cost less than $USD 10 K, 0: Otherwise
	UV	Dummy	1: If the current vehicle is a UV, 0: Otherwise
	Medellin-Cali	Dummy	1: If the respondent city is Medellin or Cali, 0: Otherwise
	Barranquilla- Bucaramanga	Dummy	1: If the respondent city is Barranquilla or Bucaramanga, 0: Otherwise

Table 2
City profiles.

City	[1]Population Metropolitan Area (millions)	[2]Motorisation (cars/1000 inh)	[3]Modal Share					[1]GPD per capitaUSD
			Public Transport	Active modes walking + Cycling	Car + Taxi	Motorcycle	Others (including informal)	
Bogotá	8.8	154	38%	38%	15%	4%	5%	9300
Medellín	4.1	133	34%	29%	20%	12%	5%	8250
Cali	3.0	136	22%	37%	20%	16%	5%	8073
Barranquilla	2.1	110	33%	32%	15%	7%	13%	6275
Bucaramanga	1.2	138	38%	16%	21%	20%	5%	10,823

Sources [1] www.dane.gov.co; [2] www.mintransporte.gov.co; [3] Mobility surveys (www.movilidadbogota.gov.co; www.metropol.gov.co; www.cali.gov.co, www.barranquilla.gov.co;www.bucaramanga.gov.co).

Table 3
Respondent socioeconomic characteristics.

	Attribute	%	Attribute	%
Gender	Male	68.60%	Female	31.40%
Occupation	Employed	47.10%	Retired	4.60%
	Independent	21.70%	Housewife	2.10%
	Student	22.80%	Other	0.10%
	Unemployed	1.60%		
Educational level	Elementary	0.80%	College	55.50%
	High-School	11.90%	Graduate	24.40%
	Technical	7.30%		
Social Stratum	1	0.30%	4	32.80%
	2	5.80%	5	26.20%
	3	25.50%	6	9.50%

Table 4
Respondent vehicle information.

	Attribute	%
Vehicle type	Automobile	74.0%
	UV	26.0%
Engine size	<1.6	34.1%
	1.6–2.4	46.3%
	>2.4	19.6%
Fuel	Gasoline	88.3%
	Diesel	8.3%
	NGV	3.4%

As Fig. 1 shows, car users prefer to invest in private transport infrastructure than in public transport. We observe that car users prefer free rather than charged on-street parking. Also, they seem to prefer eliminating gasoline taxes to reduce the price, the desire for investment in green areas, and developing infrastructure for non-motorised modes can be envisaged.

Table 5
Support for government policies.

Alternative 1	1	2	3	4	5	Alternative 2
1. Invest in highways and road expansion for car transit						Invest in public transport, improving the BRT infrastructure
2. Parking charge in public areas						More public areas available for parking
3. Use sidewalks for parking and additional lanes						Use sidewalks for green areas, bike paths and pedestrians
4. Raise gasoline taxes to reduce use and emissions						No gasoline taxes to lower the price
5. Keep vehicle circulation free						Congestion charging
6. Invest public resources in public transport for better service without raising prices						Invest public resources in gasoline subsidies for lower operational cost

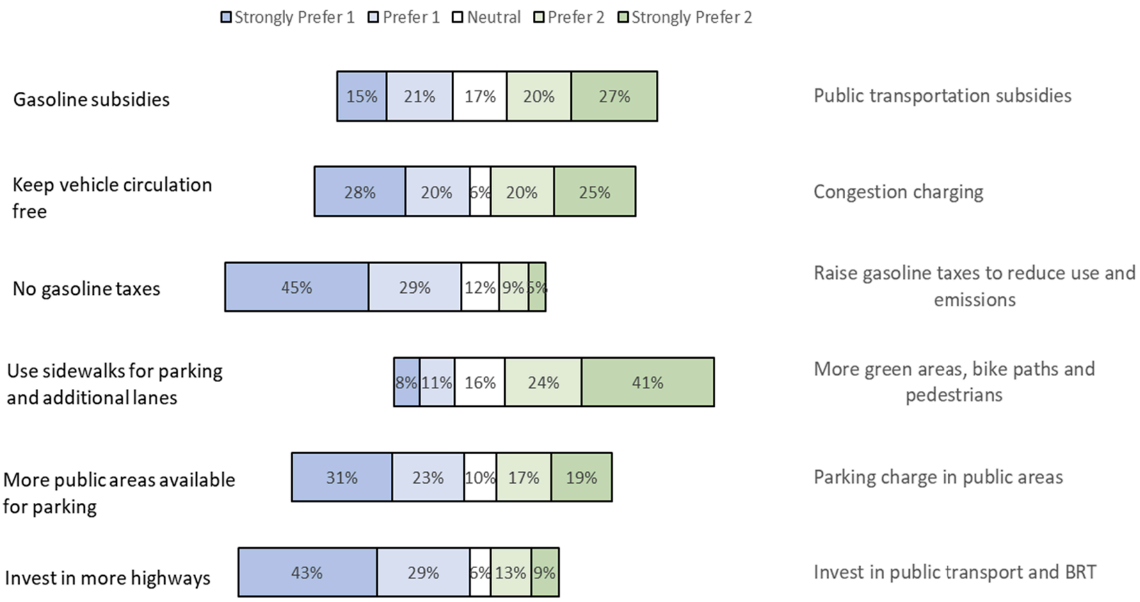

Fig. 1. Responses to support for government policies.

We also asked the respondents to evaluate statements about environmental concerns and attitudes towards technology and car use using a five-point Likert scale. Table 6 shows that most respondents recognise air quality as a problem that affects their wellbeing; they also want industries to use recycled products as a standard practice. They confirm that caring for the environment is not an obstacle to progress. Nevertheless, classifying garbage for recycling at home is not applied regularly in their own homes.

On the other hand, according to the collective knowledge that products are not more valuable than the environment, people prefer environmentally friendly products and energy-efficient vehicles. Consequently, according to the respondents' point of view, we can see an environmental awareness in the answers because the indicators showed the expected orientation according to the authors' hypothesis.

The third group of indicators (see Table 7) is related to the attitudes towards car use. According to the results, there is a tendency to feel safer when driving big cars and an indisputable status given to the vehicle. The respondents have mixed responses to public transport or taxis when their vehicles do not work. Also, they have a slight tendency to leave their cars at home for short-distance trips.

The fourth group of indicators, numbered from 19 to 23 (Table 8), is technology-related. They show a tendency for respondents to be very adaptable to technology because they like to use top-notch tech and think that problems can be solved with technology. On the other hand, most respondents prefer to use proven technology, even if it is not the newest.

Table 6
Environmental concern indicators.

Indicator	1	2	3	4	5
7. Air pollution does not affect my life.	54%	19%	11%	8%	9%
8. We classify the garbage in my household for recycling.	33%	14%	20%	12%	22%
9. I would rather use low-consumption vehicles, even if they are more expensive.	7%	11%	30%	22%	32%
10. The benefits of new products are more important than the air pollution generated by their use and manufacture.	33%	25%	25%	9%	9%
11. Industries must be required to use recycled products.	2%	4%	13%	19%	62%
12. Economic development and a decrease in poverty are more significant than the environment.	21%	19%	38%	13%	10%
13. I would rather buy environmentally friendly items, even if they are more expensive.	5%	17%	22%	19%	36%

Table 7
Attitudes towards car use indicators.

Indicator	1	2	3	4	5
14. I would rather use a small car, even if it has less power.	22%	22%	20%	14%	22%
15. I feel safer in a big car.	17%	14%	21%	17%	32%
16. The car is vital in my life.	14%	16%	27%	19%	24%
17. When my car does not work, I would rather use public transport instead of a taxi.	25%	13%	16%	19%	28%
18. I use my vehicle for all my trips, even for short distances.	24%	20%	23%	15%	19%

Table 8
Attitudes towards technology.

Indicator	1	2	3	4	5
19. I like top-notch technology.	4%	7%	23%	25%	40%
20. Most problems could be solved with technology.	6%	10%	34%	25%	24%
21. Technology does more harm than good.	37%	27%	24%	7%	4%
22. Environmental requirements are an obstacle to progress.	57%	20%	15%	7%	2%
23. I would rather use proven technology than an unproven novelty, even if it is not the newest one.	8%	9%	30%	19%	35%

Finally, we asked the respondents to rank five transport policies. This section aimed to see the relative importance of each policy across the population. Fig. 2 shows that the most approved transport policy was the construction of highways; the second policy was a gasoline subsidy, and the least desired measure was congestion charging. We expected these results because the people surveyed were car owners, and there was a high chance for them to prefer measures that incentivise private transport. The third and fourth policies were an investment in non-motorised mode infrastructure and investment in public transport.

5. Results

Four latent variables were defined through exploratory factorial analysis: (a) Support for green transport policies (GP); (b) Environmental concern (EC); (c) Attitudes towards car use (PC) and (d) Attitudes toward technology (TEC). Out of the four latent variables defined, we used three (EC, TEC and PC) for clustering purposes and the last (PG) for profiling. Some indicators were discarded in the process, giving a total of 13 out of 23 indicators used. Table 9 shows EFA results and the latent variable reliability. All indicators have loadings higher than 0.5, except *Technology does more harm than good* (I21). All latent constructs present an acceptable Cronbach's alpha (>0.6), suggesting that the set of items can be considered as closely related as a construct.

5.1. MIMIC model

Fig. 3 shows the model framework used to estimate the MIMIC model, which aims to segment the respondents into clusters. The structure of the model is inspired by Soto et al. (2018b). The model was estimated in the R software using the Lavaan package (Rosseel, 2012), which allowed us to consider categorical indicators (see Table 10). For identification issues, it was necessary to fix one

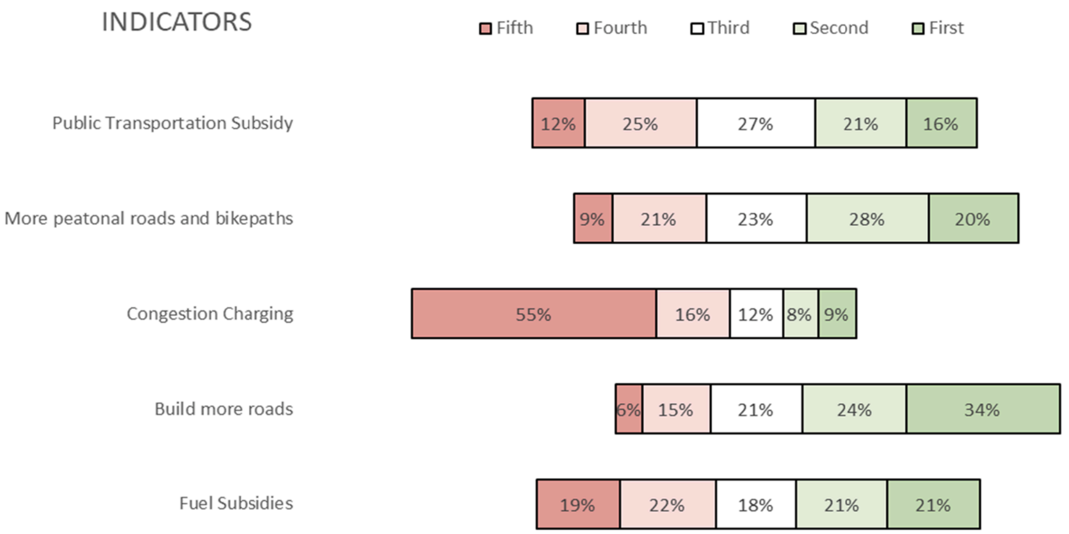

Fig. 2. Ranking of policies.

Table 9
EFA results and Constructs' reliability.

Item	Statement	Latent Variable				Cronbach's Alpha
		PG	EC	TEC	PC	
I2	Parking charge in public areas	**0.785**	0.140	<0.05	<0.1	0.7
I4	Raise gasoline taxes to reduce use and emissions	**0.687**	<0.05	<0.05	0.148	
I5	Allow congestion charging	**0.770**	<0.1	0.101	<0.1	
I3	Use sidewalks for green areas, bike paths and pedestrians	<0.05	**0.599**	<0.05	0.243	0.69
I7*	Air pollution does not affect my life	<0.1	**0.724**	<0.05	<0.05	
I22*	Environmental requirements are an obstacle to progress	<0.05	**0.664**	<0.05	0.139	
I11	Industries must be required to use recycled products.	<0.05	**0.562**	0.341	<0.05	
I19	I like top-notch technology	<0.05	<0.1	**0.797**	<0.05	0.61
I20	Most problems could be solved with technology	<0.05	<0.05	**0.766**	<0.05	
I21*	Technology does more harm than good.	<0.05	<0.05	**0.490**	0.156	
I16	The car is vital in my life	<0.1	<0.05	0.141	**0.774**	0.6
I17*	When my car does not work, I would rather use public transport instead of a + taxi	0.170	<0.1	<0.05	**0.721**	
I18	I use my vehicle for all my trips, even for short distances	0.104	0.170	0.150	**0.613**	

* These indicators were reversed for exploratory factor analysis. PG: Support for green transport policies, EC: Environmental Concern, PC: Attitudes towards car use, TEC: Attitudes towards technology.

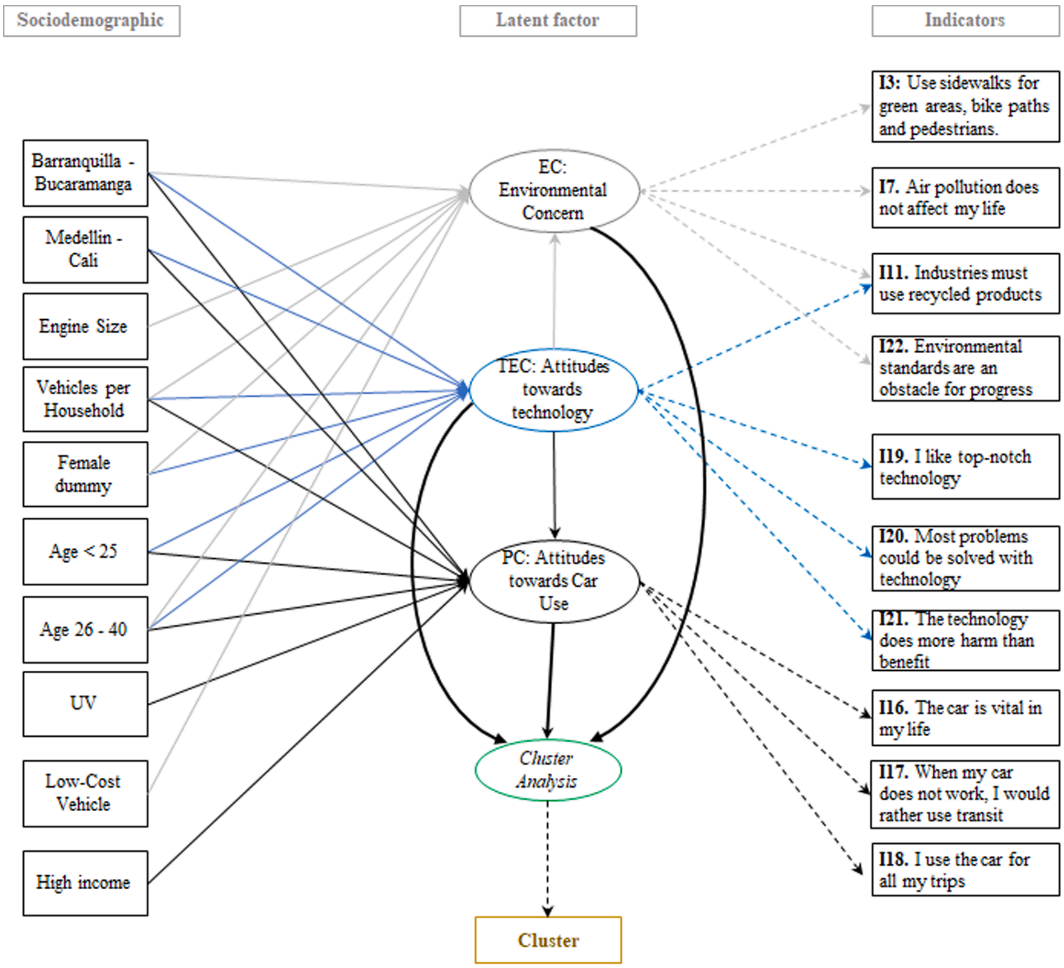

Fig. 3. The MIMIC model framework.

indicator's coefficient per latent variable.

Regarding the socioeconomic variables related to the latent variables, we tested each relationship between latent and socioeconomic variables, but we only kept significant relationships. An interesting finding was the significant relationship between the latent variable TEC with EC and PC. For that matter, the latent variable model has a factor on factor regression.

Table 10
Results of the MIMIC model results.

Variable	Cause	Estimate	P-value
TEC	Vehipers	0.260	0.003
	Gender	−0.181	0.010
	Age25	0.378	< 0.001
	Age40	0.306	< 0.001
	Barranquilla-Bucaramanga	−0.173	0.083
EC	Vehipers	−0.700	< 0.001
	Age25	−0.194	0.030
	Age40	−0.152	0.045
	Gender	0.196	0.004
	Pro-Tech	0.333	< 0.001
	Medellin-Cali	1.070	< 0.001
	Barranquilla-Bucaramanga	0.578	< 0.001
PC	Vehipers	0.127	0.003
	HighClass	0.127	< 0.001
	Engine Size	0.130	0.003
	Low-Cost	−0.103	0.005
	Age25	−0.121	0.005
	Pro-Tech	0.108	0.002
	Medellin-Cali	0.577	< 0.001
	Barranquilla-Bucaramanga	0.351	< 0.001
I11	**EC**	0.525	< 0.001
I7		0.563	< 0.001
I3		0.925	< 0.001
I22		1	Fixed
I17	**PC**	2.273	< 0.001
I18		0.268	0.069
I16		1	Fixed
I3		−0.788	< 0.001
I19	**TEC**	1	Fixed
I20		0.333	0.002
I21		0.795	< 0.001
Goodness of fit indicators			
Degrees of freedom			87
Chi-square			171.042
p(Chi-square)			0
$p(\chi^2)$/df (<3)			1.97
CFI (>0.9)			0.955
TLI (>0.9)			0.977
RMSEA (<0.05)			0.030

The model has an acceptable goodness of fit (Lucchesi et al., 2020a; 2020b). First, the chi-squared is significant; the GFI and TLI are above 0.95, the RMSEA is 0.030, and the ratio of the chi-square and the degree of freedom indicator is under 2. Furthermore, considering the model estimators, the model performs adequately, with almost all relationships over the 95% confidence level in the structural and measurement equations.

The results indicate that men and youth have more vigorous attitudes towards technology; the same happens in households with higher vehicles per capita rates. Regarding environmental concerns, women exhibit a more profound concern than men do. Also, as higher engine size and vehicle per capita rates show, the respondent's environmental concern is lower, as expected. Older, high-income people show strong attitudes towards car use. On the other hand, preferences for large engines and more cars per household demonstrate a greater car attachment. Furthermore, older, well-educated people support green transport policies. The model also includes two dummy variables regarding the city. The dummy variable grouping people of the two less populated cities (Barranquilla and Bucaramanga) has a negative effect on the TEC latent variable but a positive effect on Environmental Concerns and Attitudes Towards Car Use. Interestingly, individuals from Medellin and Cali exhibit deeper environmental concerns but stronger attitudes

Table 11
Results of the mediation analysis.

Variable	EC		PC	
	Estimate	P-value	Estimate	P-value
Gender	0.136	0.041	−0.020	0.043
Vehipers	−0.614	<0.001	0.155	<0.001
Age 25	−0.068	0.428	−0.080	0.052
Age 40	−0.050	0.489	0.033	0.013
Bucaramanga-Barranquilla	0.521	<0.001	0.332	<0.001
Medellin-Cali	1.070	<0.001	0.577	<0.001

towards car use than those from other cities.

Given that the MIMIC model has a factor on factor regression -EC and PC-, some socioeconomic variables from the structural equations directly affect the mentioned latent variables. However, there are also indirect effects through factor regression TEC. We performed a mediation analysis using the Lavaan package (Rosseel, 2012), which allowed us to estimate the full effect of socioeconomics and their significance on the latent variables. Therefore, as shown in Table 11, most variables remained highly significant on the latent variables, except for the age variables on Environmental Concern. Although there is an indirect effect, the main orientation and significance persist in the model.

The MIMIC model shows that the use of attitudes towards technology as a factor on factor regression with environmental concern and car use attitudes turns out to be significant, over 99%. The signs of the relationships are positive for the two latent variables, which means that pro-tech people have more positive attitudes towards car use and have a more significant environmental concern. A similar finding has been found by Jansson et al. (2009) regarding a segment of the population with the firmest pro-environmental beliefs and a high adoption rate of new eco-technologies.

5.2. Cluster analysis

At the next stage, we conducted a clustering analysis using the K-means procedure for segmentation purposes. The K-means procedure is an unsupervised Machine Learning technique, a distance-based approach among observations and the cluster's centroids. Similarly to Mokhtarian et al. (2009), cluster analysis lets us identify market segments.

The observations are assigned to the nearest centroid iteratively. Then, the centroid is recalculated for each iteration with the values of the observations belonging to it until the assignments stop changing. The number of clusters was selected using the NBClust R-package (Charrad et al., 2014), which provides 30 indices for determining the optimal number of clusters. We determined the number of clusters considering the majority of indices. Under this procedure, the optimum number of clusters for the sample was three, and the k-means was then estimated with 100 different initial values to assess consistency in the results. All observations were classified, so no solution of outliers was needed. We used the predicted values of the latent variables for each respondent to estimate the respondent clusters. The results suggest three clusters: 1) *All Matters*, 2*) Green Conscious*, and 3) *Traditionalists*, giving an interpretable solution for the database. Table 12 shows the socioeconomic and vehicle ownership characteristics of each cluster.

According to Table 10, it can be noticed that in the *Traditionalists* cluster, the respondents show the least environmental concern and do not have a consolidated technology culture, but they show attachment to vehicle use. The *All Matters* cluster represents the respondents with the most solid attachment to car use, the highest attitudes towards technology, and deep environmental concern. Finally, in the *Green Conscious* cluster, the respondents show high levels of environmental concern, unwavering support for green transport policies, low attachment for car use, and the least pro-technology attitudes than the previous clusters.

Regarding the support for green transport policies, as expected, the *Green Conscious* cluster has the highest support for green transport policies, followed by the *Traditionalist* cluster. Additionally, despite significant environmental concerns, the *All Matters* cluster has the lowest support for green transport policies, which is expected since most policies restrict car use.

Related to the socioeconomic characteristics, most respondents with a UV belong to the *All Matters and Traditionalists* Clusters, leaving the *Green Conscious* cluster with the smallest UV percentage. The *Green Conscious* cluster is formed mainly by individuals with one small engine car per household instead of the *All Matters* cluster, which has a high percentage of respondents with UVs and the highest rate of homes with more than one vehicle. The *Traditionalists* cluster has respondents from one vehicle to two-vehicle households, with the highest big engine vehicles.

Regarding the socioeconomic characteristics per cluster, the *Traditionalist* and *All Matters* cluster have the highest percentage of men. The *Green Conscious* cluster has the highest percentage of women. In terms of age, the *Traditionalists* cluster is made up of 47.1% middle-aged adults and 24.8% of adults older than 40. The *Green Conscious* cluster has the highest percentage of older adults, with 50% and a high percentage of middle-aged adults (29%). The *All Matters* cluster has the youngest adults of all the clusters, with 30.3%. Regarding income, using the socioeconomic class as a proxy variable, the *All Matters* cluster has the highest share of high-income users (43.2%) and the lowest share of low-income users (5.5%). In comparison, the *Traditionalist* cluster has the highest share of low-income respondents (6.8%) and the lowest percentage of high-income (27.1%).

Table 13 shows the ANOVA results, comparing the percentages related to socioeconomic variables, vehicle characteristics and the latent profiling variable, to verify significant differences among clusters. We used different levels of significance on Table 13 (p-value < 0.01, p-value < 0.05 and p-value < 0.15, as explained on the footnote). There are significant differences in almost all variables between clusters 1 and 2, and clusters 2 and 3. The *Green Conscious* cluster has significantly lower vehicles per household, engine sizes, low-cost vehicles and middle-aged and older adults. On the other hand, *All Matters* and *Traditionalist* clusters have significant differences in income and support for green transport policies. There are no significant differences between Low-Income people among clusters because they have similar shares.

There is a significant difference between the three clusters regarding the latent variable support for transport policies. However, there is an effect seen on some variables that show no differences between clusters 2 and 3, but they are different from cluster 1. This can be caused by the correlation between the clusters on the latent variable and its predictors.

5.3. Results per city

Tables 14 and 15 show cities' differences regarding the percentage of each cluster and the latent variables' values. The lowest percentages of *Green Conscious* are in Bogota and Medellin, the two most populated cities in Colombia. As a paradox, the cities with the

Table 12
Characteristics of socioeconomic class and car ownership among clusters.

Cluster		1 *All Matters*	2 *Green Conscious*	3 Traditionalists	% Sample
% of Respondents		35.2%	26.5%	38.3%	100%
Latent Variables (Clustering)	EC	0.76	0.75	−0.31	–
	TEC	0.81	−0.11	0.10	–
	PC	0.66	0.45	0.38	–
Latent Variables (Profiling)	PG	−0.48	0.60	−0.09	–
Gender	Female	29.0%	37.3%	29.1%	31.20%
	Male	71.0%	62.7%	70.9%	68.80%
Age	< 25	30.3%	20.7%	28.1%	26.90%
	26 – 40	44.0%	29.3%	47.1%	41.30%
	> 40	25.7%	50.0%	24.8%	31.80%
Socioeconomic Class	Low (SES 1 and 2)	5.5%	5.8%	6.8%	6.10%
	Medium (SES 3 and 4)	51.4%	55.8%	66.2%	58.20%
	High (SES 5 and 6)	43.2%	38.4%	27.1%	35.70%
Cars per household	1	65.6%	71.0%	67.7%	67.80%
	2	34.4%	29.0%	32.3%	32.20%
Vehicle Type	Automobile	73.2%	77.9%	72.7%	74.30%
	UV	26.8%	22.1%	27.3%	25.70%
Engine Size	<1.6	32.5%	38.8%	31.3%	33.70%
	1.6–2.4	47.3%	48.2%	45.1%	46.70%
	>2.4	20.2%	13.0%	23.6%	19.60%

Table 13
Anova results.

Cluster		1 *All Matters*	2 *Green Conscious*	3 Traditionalists
Latent Variables (Profiling)	PG	−0.48	0.6***+++	−0.09**+++
Gender	Female	0.28	0.37**++	0.29++
	Male	0.72	0.63**++	0.71++
Age	< 25	0.3	0.21**++	0.28++
	26 – 40	0.44	0.29***+++	0.47+++
	> 40	0.26	0.5***+++	0.25+++
Socioeconomic Class	Low (SES 1 and 2)	0.05	0.06	0.07
	Medium (SES 3 and 4)	0.51	0.56+++	0.66***+++
	High (SES 5 and 6)	0.43	0.38+++	0.27***+++
Cars per household	1	0.66	0.71**	0.68
	2	0.34	0.29**	0.32
Vehicle Type	Automobile	0.73	0.78*+	0.73+
	UV	0.27	0.22*+	0.27+
Engine Size	<1.6	0.33	0.39*++	0.31++
	1.6–2.4	0.47	0.48	0.45
	>2.4	0.2	0.13**+++	0.24+++
Low Cost Vehicle		0.61	0.73***+++	0.56*+++

*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.15 (Cluster 1 vs Cluster 2 or 3)
+++ p-value < 0.01; ++ p-value < 0.05; + p-value < 0.15 (Cluster 2 vs Cluster 3)

Table 14
Cities percentage of respondents per cluster.

Cluster	City				
	Bogota	Bucaramanga	Medellin	Cali	Barranquilla
1. *All Matters*	17.50%	20.50%	50.00%	51.14%	35.40%
2. *Green Conscious*	6.00%	33.50%	22.45%	40.64%	28.32%
3. *Traditionalists*	76.50%	46.00%	27.55%	8.22%	36.28%
Sample	200	200	196	219	226

worst air quality out of the five included, which could also mean that their inhabitants have a higher acceptance threshold for environmental concern and are accustomed to worse air quality conditions.

Regarding the *All Matters* cluster, Bogota and Bucaramanga have the lowest percentages considering all cities. Even though all cities have BRT systems, Bogota has the densest public transport network, the highest number of transit riders, the highest share of cyclists, and the worst congestion levels, possibly contributing to such a low share of All Matters among cities. On the other hand, Medellin has

Table 15
Latent variable scores per city.

City	Bogota (*)	Bucaramanga ($^{+}$)	Medellin ($^{\circ}$)	Cali ($^{-}$)	Barranquilla ($^{\wedge}$)
EC	$-0.23^{+\circ-\wedge}$	$0.28^{*\circ-}$	$0.42^{*+-\wedge}$	$0.92^{*+\circ\wedge}$	$0.29^{*\circ-}$
TEC	$0.33^{+\circ}$	$0.09^{*\circ-\wedge}$	$0.44^{*+-\wedge}$	$0.34^{+\circ}$	$0.27^{+\circ}$
PC	$0.16^{+\circ-\wedge}$	$0.41^{*\circ-}$	$0.74^{*+\wedge}$	$0.71^{*+\wedge}$	$0.45^{*\circ-}$
PG	$0.15^{\circ-\wedge}$	$0.25^{\circ-\wedge}$	$1.5^{*+-\wedge}$	$-0.5^{*+\circ\wedge}$	$-0.99^{*+\circ-}$

several multimodal options for making trips, including Metro, BRT and LRT, but has a high share of respondents from the first cluster, which could be due to the city's topography (high slopes) and the difficulty to walk long distances. The cases of Cali and Barranquilla were expected due to several factors. An increasing motorisation rate, BRT systems with financial difficulties after several years of operation, and a more aggressive environment in terms of temperature seem to affect the user experience and discourage active transportation (Arellana et al., 2020c). The highest percentage of the *Traditionalist* cluster is in Bogota, with 3 out of four respondents belonging to this cluster, followed by Bucaramanga with 46%. Medellin and Barranquilla have 28% and 36%, respectively, and Cali has the lowest percentage, with 8.22% belonging to the *Traditionalist* cluster.

Table 14 shows latent variable scores per city. As each city cluster percentages show, the lowest average values for the pro-car latent variable occur in Bogota and Bucaramanga, the cities with the least percentage of this cluster. The same can be seen with the environmental concern, which is lower in cities with fewer respondents on the *Green Conscious* cluster. Attitudes towards technology are similar among cities, while Cali has the greatest environmental concern. It could be seen that the city with the highest support for transport policies is Medellin, which turns out to have the best and most diverse public transportation network. In Table 14, each city has a symbol with latent variable scores if significantly different at the 95% confidence level. For example, the value of $0.28^{*\circ-}$ in Table 14 indicates a latent variable score of 0.28 for EC in Bucaramanga. Also, it shows significant differences between this city score and three cities (i.e. Bogotá*, Medellin$^{\circ}$ and Cali^{-}). However, the difference between these latent variable (EC) scores was not significant for Bucaramanga and Barranquilla.

5.4. Implications for policy

It can be observed through the cluster segmentation of the population that there are differences in the characteristics related to attitudes, socioeconomic class and car ownership among clusters. Hard measures (fiscal) and soft measures (campaigns) are needed to promote sustainable transport policies. Fiscal measures would affect all people, as price discrimination is difficult to achieve in specific contexts. Therefore, the marketing and promotional campaign guidelines need to be specific for each cluster to address the potential market.

For instance, the *All matters* cluster includes people with a high level of concern for the environment but little interest in policies that encourage alternative means of transport; instead, they are very attached to the vehicle and performance. For those consumers, it should be hard to switch modes to a more sustainable one. However, alternative fuel vehicles can be promoted among consumers of this cluster. When promoting AFVs, the campaign must be addressed towards the technical and technological advances, the performance advantages and the status of having an AFV. Also, lowering taxes or providing purchase price subsidies for AFVs could promote their adoption. Hard measures also need to be enacted to discourage car use, like congestion charging, raising gasoline prices to promote alternative fuels and differential taxes by engine size, punishing big engine automobiles and SUVs.

The *Green Conscious* cluster has the most ingrained environmental concern and support for green transport policies among the respondents. In this context, this cluster seems to be the easiest to encourage to make a mode switch. In order to achieve this, hard measures to incentivise active modes of transport could be addressed, such as improving infrastructure for walking and cycling and encouraging public transit use. Regarding marketing campaigns for this cluster, there is a need to reinforce the environmental message and the benefits of the alternative modes of transport regarding sustainability, health, efficiency and operational costs. Also, for individuals belonging to this cluster who are resistant to switch modes, the advertising could focus on the green qualities of the proposed measure, like emission reduction and less harm to the environment, to approach this cluster.

Regarding the *Traditionalists* cluster, which is the biggest one, many medium-income consumers are indifferent to environmental concerns and green transport policies. For these people, changing the mode of transport could be an option but not for environmental or sustainability reasons. AFVs could be promoted in this cluster, but the capital cost could be a major drawback. For the AFV to gain market share in this cluster, a series of policies, like tax incentives, may be considered. Also, this cluster might be prone to shift mode from private car to public transport if adequate investments are made, such as providing facilities like exclusive lanes to reduce travel time and make public transport more appealing.

For example, it is normal for marketing campaigns to show happy and stress-free car users riding on congestion-free highways; in contrast, news about public transport tends to be related to discomfort and security issues. For this reason, soft measures need to be addressed to reinforce negative aspects of car use, like congestion and promote public transport benefits in efficiency and lower operational costs. This contributes to reducing the generalised view of the car as a status symbol and the traditionalist behaviour in the Global South context.

Differences among cities should be taken into account when promoting sustainable transport policies. For instance, all studied cities have BRT systems that are operating. However, the reality of each system is different among them. On the one hand, Bogotá has over 2 million rides per day in its BRT system. On the other hand, Bucaramanga, Cali and Barranquilla BRT systems have been on the edge of bankruptcy due to a lack of daily passengers. Bogotá decided to expand the bikeways network, adding >80 km due to the COVID-19 pandemic during 2020 to complete a network of 550 km, while the other cities have adopted more modest policies to promote active transportation.

Also, our results help implement policies like congestion charging, which should consider the attachment for car use in the city. In Colombia, Bogotá and Medellín authorities are studying the implementation of congestion charge schemes. The largest differences between the percentages of the *All Matters* cluster needs to be considered when targeting policies for each city. Furthermore, there is a need to communicate the real cost of car ownership, which tends to be underestimated (Andor et al., 2020). In such a scenario, as social influence has been proven to be significant in adopting a car-free lifestyle, high-status non-car-owners could promote the lifestyle (Jansson et al., 2017b; Rezvani et al., 2018).

Finally, a marketing campaign that promotes environmentally friendly habits must be carried out to raise environmental awareness since a high number of respondents showed a low level of environmental concern.

6. Conclusions

This article proposes using structural equation models and cluster analysis for market segmentation when planning and implementing sustainable mobility policies. The model considers perceptions and attitudes through latent variables regarding an environmental concern, attitudes towards technology, car use, and green transport policies to help understand individual behaviour. According to each group of interests and their characteristics, the results could be essential for segmented policy and marketing strategies for promoting sustainable transport policies. In the Colombian context, we identified three user categories: *Traditionalists, Green Conscious* and *All Matters*.

Individuals identified as *Traditionalists* show lower interest in environmental issues, and they have plenty of attachment to the car. Individuals in this cluster are primarily middle-aged with a medium to high income. The *Green Conscious* cluster is the "environmental group." They have high environmental concern levels, great support for green transport policies, and less car use attachment than the other categories. The standard profile is comprised of young people or households with one small-sized engine vehicle.

Meanwhile, *All Matters* are sensitive to environmental issues but show the highest level of attachment to the car. They are mainly older, high-income men who prefer vehicles with big engine sizes and UVs. Individuals in this category belong to multiple car households.

The diversity of interests, perceptions and attitudes of different segments of the population demand should be accounted for to design strategies "tailored" for each cluster. This will allow for more efficiency and opportunities for success in the implementation of sustainable transport policies. Some sectors will likely be allies, as is the case for the *Green Conscious* cluster; others, such as *All Matters* and *Traditionalists*, will most likely oppose new policies.

This research provides a framework for market segmentation when planned transport policies can be adapted to other contexts. More experimentation is required in situations where socioeconomic conditions may differ substantially from those in Colombia. The proposed instrument can be adapted and complemented to achieve better results in the specific case in which it will be applied.

Our data has some limitations on the information collected. Further research may consider surveys including the willingness to pay towards sustainable policy measures and include this variable for market segmentation. On the other hand, given that market segmentation is also related to travel patterns, travel behaviour and housing location, it could be convenient to include those types of questions in the analysis considering that some vehicle owners might be subject to self-selection measures in terms of residential location and travel preferences.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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