



Navigating acceptance and controversy of transport policies

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ABSTRACT

The current study contributes to the literature by exploring the acceptance and controversy surrounding different transport policies, examining how public preferences/attitudes explain these dispositions in the context of transitions towards more sustainable transport systems. A random and representative Norwegian-population-based sample ($n = 1002$) was used for the analysis purpose. A two-fold approach is employed. A principal component analysis is performed first to determine which transport policies (20 policies) are homogeneously evaluated. Secondly, a latent class analysis is used to classify unobserved subgroups of people and distinguish classes of acceptance/controversy patterns. We identify three distinct components of public evaluations of transport policies: “traditional pull policies” focusing on non-restrictive strategies such as incentives for public transport; “car-based push policies” focusing on actively limiting car use; and “emerging policies” focusing on innovative technologies such as electrification and automation. The latent class analysis uncovers six distinct classes, illustrating a spectrum of preferences and attitudes. These classes encompass individuals ranging from strong opposition and neutrality to strong support for various policy types. A highly environmentally conscious class, characterized by higher education levels, strongly supports diverse transport policies, including push and emerging measures, showcasing a commitment to sustainability and readiness for personal sacrifices. However, challenges arise from a class that strongly opposes all types of policies, including traditional pull measures. This class exhibits robust expectations and concerns about policy (features) impacts such as clarity, effectiveness, and fairness, and it is skewed towards a higher proportion of men, with relatively older members. Moreover, they have concerns that such policies might cause adverse consequences for them, such as additional travel time and reduced social interactions. In conclusion, the diverse patterns identified within the population highlight the need for a comprehensive approach to developing transport policies. For the transition towards more sustainable transport systems, the findings show potential for more radical transport policies compared to today’s policy landscape.

1. Introduction

Cities worldwide have been putting into action or considering a wide range of transport policies (van Wee et al., 2023). These policies play a crucial role in addressing the various challenges and opportunities associated with urban and rural living. Persistent urban traffic congestion and transport-related energy use necessitate policies like public transit promotion and road pricing to alleviate

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gridlock. High vehicular emissions also raise air quality and public health concerns, emphasizing the importance of emissions regulations and cleaner transport solutions (Winkler et al., 2023). Concurrently, the pressing global challenge of climate change compels cities to adopt different policies. These include promoting active mobility, like walking and cycling, as well as high-tech solutions like electric and autonomous vehicles to cut greenhouse gas emissions (e.g. Haugland 2023). Additionally, transport policies are supposed to address matters of infrastructure maintenance, health, land use planning, economic development, equity, accessibility, and innovation, while also adapting to shifting public opinions, preferences, and emerging technologies (Banister, 2005). In short, the complex nature of urban/rural settings and the dynamic nature of transport necessitate a comprehensive array of policies aimed at improving efficiency, sustainability, and quality of life in cities and rural areas around the world (Steg, 2003; Xenias and Whitmarsh, 2013).

Despite this, there is a scholarly gap in understanding the determinants of public perceptions of the acceptability or contentiousness of distinct transport policies¹ in light of the rapid transformations in perspectives of the public and novel policy development. Especially, the public's increasing awareness of climate change and environmental issues related to transport is likely to change perceptions of policies, although past studies have shown that the effects of such changes on policy priorities are not strong (Bakaki and Bernauer 2017). Thus, it is necessary to investigate which specific policies in the field, whether established or emerging, are more likely to be accepted or controversial, and how these dispositions are explained by public attitudes. Support for candidate transport policy options by the wider public has been expressed as one of the key factors affecting a successful implementation (van Wee et al., 2023). Past studies in the field of transport policy have mainly assessed people's (acceptability) acceptance of a single policy or combination of a few policies. For example, there have been several studies on the acceptance of congestion charging schemes (see Li and Hensher, 2012; Gu et al., 2018). However, there is no comprehensive knowledge of how people accept or oppose a wide range of distinct transport policies including both established and emerging candidate transport policies. This research objective aligns with the first avenue for future research outlined in a very recent discussion paper published by van Wee et al. (2023, p84). As discussed by van Wee et al. (2023), our objective was not to label policy options ourselves as controversial, because controversial issues tend to emerge in the interaction between specific publics and issues. Therefore, based on a survey conducted in Norway, our aim was to acquire an updated perspective on the public's comprehension and evaluation of these options, gauging whether the policies are perceived as acceptable or controversial by the public. Nonetheless, based on the current knowledge, we expect that the public is more likely to support so-called "pull" measures and less likely to support "push" measures (see Section 2 for the definitions).

Employing a random and representative Norwegian-population-based sample ($n = 1002$), the current study evaluates public opinions regarding different transport policies and investigates which attitudinal variables and perceptions are (are not) related to such policies. A wide range of push and pull measures (policies) from traditional or low-tech solutions to emerging or high-tech solutions will be assessed. We contribute to the state of the art of research by identifying distinct classes of acceptance and controversy regarding a wide range of transport policies. We investigate how different attitudes towards transport policies (e.g., efficiency, fairness, environmental friendliness) can be related to pushes, pulls, and emerging policies in the transport sector. In addition, we reveal which segment of citizens (and what percentage of the population) tend to be more receptive or resistant to such policies.

To navigate the acceptance and controversy surrounding transport policies, we employ a two-fold approach. A principal component analysis (PCA) is performed first to determine which transport policies are homogeneously evaluated by reducing the dimensionality of the data. By doing so, we will be able to identify several components (factors) that can be used to identify some policy categories (e.g., emerging policies versus traditional policies). Secondly, we employ a latent class analysis to identify unobserved subgroups of people and distinguish classes of acceptance/controversy patterns. By using this method, we will be able to determine which combinations of pull and push policies people support or oppose. As such, we use all evaluated policies as indicators of a latent class model (Vermunt & Magidson, 2004), thereby exposing any (in)consistencies among them. We use the results of the PCA to better interpret the results of the latent class model. Dimensions identified by PCA can inform us about the inherent structure of policy evaluations, while LCA can help in understanding how different groups of individuals contribute to these patterns. In addition, we profile the classes in terms of attitudes towards transport policies, including perceptions of factors such as effectiveness and fairness, as well as socio-demographic factors (i.e., age, gender, and education). In Section 3, we explain the rationale for the correlation between these attitudes and policy acceptance. These variables may play a role in shaping latent class membership. Therefore, they are seamlessly incorporated into the class membership function, forming an integral component of the model. Some classes will likely be "consonant", e.g., a class with citizens who are more interested in pull measures or less supportive of push policies, but some classes will likely also be "dissonant", those who support push measures or oppose pull policies. This analysis can provide insight into which groups/combinations of acceptance/controversy are actually present and their relative sizes.

2. The history of transport policies

The history of transport policies has undergone a significant transformation to address various challenges associated with the promotion of sustainable transport (Goodwin, 1999; Banister, 2005; Van Wee, 2009). These policies have employed a combination of "push" and "pull" measures to achieve their goals (Stopher and Stanley, 2014). Push measures, typically regulatory or restrictive in nature, have been introduced to manage issues like traffic congestion. Zoning regulations, for instance, congestion charging, tolls, low emission zones, and carpool lanes were implemented to regulate traffic flows, while parking regulations/pricing and vehicle access restrictions in city centers have helped alleviate congestion.

¹ In this study, we focus on policies that are intended to reduce energy consumption, traffic emissions, and congestion in urban transport. Accordingly, other policies, for example, with specific safety-related outcomes were beyond the scope of this study.

Concurrently, pull measures have been implemented to promote sustainable transport and reduce car dependency (Steg, 2007). The development and improvement of public transport systems, as well as the creation of bike lanes and pedestrian-friendly infrastructure, have encouraged alternative modes of transportation (Hrelja and Rye, 2023). Carpool and ridesharing programs were established to reduce single-occupancy vehicle use, and incentives for electric vehicles (EVs) (Hoerler et al., 2023) were introduced to combat air pollution and greenhouse gas emissions. These measures aimed to provide incentives for eco-friendly transport choices. Public awareness campaigns, car-free days, eco-driving, retrofitting, or scraping/replacing fossil-fuel cars along with land use policies such as proximity to amenities via 15-minute cities concepts have also been part of the transport policy discourse (Sheeper et al., 2014; Henry and Gordon, 2003; Farda and Balijepalli, 2018; Huang et al., 2018; Van Wee et al. 2011; Haugen and Vilhelmson, 2013).

In recent years, emerging strategies in transport policy have focused on innovation and technology (Cassetta et al., 2017). Shared mobility platforms and micro-mobility solutions have been introduced to provide integrated, user-friendly solutions for various modes of transportation, promoting flexibility and sustainability (Zhu et al., 2023; Aduljabbar et al., 2021). Autonomous vehicles and smart traffic management systems are being developed to improve traffic flow and reduce congestion (Faisal et al., 2019; Souza et al., 2017). Policies promoting zero-emission vehicles (e.g., hydrogen cars) and urban planning (e.g., biophilic design) are evolving to address environmental concerns (Keith and Farrell, 2003; Cabanek et al., 2020). Additionally, new strategies such as mobility credits, and urban air mobility are being developed to better manage the congestion and emissions (Aziz et al., 2015; Straubinger et al., 2020). The ongoing evolution of transport policies reflects a growing commitment to creating more efficient and sustainable transportation systems. It is important to acknowledge that the landscape of transport policies is in constant flux, and that there are strong national and regional variations in the types of policies that become implemented. While these policies hold significant relevance, there could be other strategies that warrant consideration. We have chosen the specific policies analyzed in this survey because they are prominent in the current discussion of urban transportation challenges in Norway. Transport policies in Nordic countries, especially Norway, have prioritized electrification strategies and technology-oriented solutions, especially for climate and sustainability challenges. The Norwegian energy system is characterized by a high proportion of renewables (98 %), making transport electrification an attractive strategy for reducing domestic greenhouse gas emissions. By implementing strong economic incentives to support the transition from fossil fuel private cars to EVs, Norway has become a global leader in electric mobility, with EVs accounting for nearly 80 % of new registered car.² However, it is becoming increasingly clear that relying on private cars for transportation poses significant challenges for the transport system (Ryghaug and Skjølsvold, 2023). These challenges include congestion, pressure on ecosystems due to increased infrastructure needs, and land-use issues (Aguilera and Cacciari, 2020; Tørnblad et al., 2014). Additionally, electric vehicle adoption may be hindered by grid capacity limits, and support schemes for EVs might have unintended economic distributional effects across different socio-demographic groups which can create strong policy backlashes. The increase in EVs on the road may strain the electrical system, resulting in congestion and slow charging if the electrical system is not upgraded. Support policies, meant to boost EV adoption, might make economic inequality worse by favoring wealthier individuals. This unfairness could cause backlash from marginalized groups, pushing for policy changes. Thus, there is now a greater urgency to investigate a wider range of complementary and alternative transport policy strategies, which gives importance to the focus of this paper (Klimatutvalget, 2023). Looking to Norway, which represents a policy context of a far-transgressed transportation transition, offers additional opportunities to gain knowledge that can be valuable for other regions that currently are in earlier stages of development.

3. Potential correlates of public acceptance of transport policies/strategies

Studies in the field of transport policy have focused primarily on the acceptance of a particular policy by the general population. The findings of past empirical studies indicated that a variety of (perceptions) attitudes with respect to policies could be critically important in determining acceptance. These attitudes illuminate the correlates behind why certain strategies may be embraced while others face opposition.

One of the attitudes³ assessed is the preference for strategies that are simple in their details. This perspective underscores the importance of clear and straightforward policies, suggesting that people are more likely to accept strategies that are easy to understand and implement (Gu et al., 2018). Additionally, the desire for clarity in certain characteristics of the strategy highlights the importance of transparent and well-defined elements within a policy. This calls for policymakers to craft strategies with clearly articulated features to gain public acceptance (Gu et al., 2018).

Trust in policymakers and the government plays a pivotal role in policy acceptance (Cools et al., 2011; Huber and Wicki, 2021). By gauging the level of trust that individuals have in government decisions regarding these strategies, the study can elucidate the role of trust in policy implementation. High levels of trust can enhance the likelihood of successful strategy adoption, making it an essential aspect to consider in policy design (Cools et al., 2011; Sun et al., 2016; Mehdizadeh and Shariat-Mohaymany, 2020).

Effectiveness, fairness, and financial implications are core factors that guide public acceptance (Zheng et al., 2014; Mehdizadeh and Shariat-Mohaymany, 2021; Dugan et al., 2022; Hössinger et al., 2023). Assessing the significance people attach to the effectiveness and fairness of strategies can provide valuable insights into their priorities. This information can guide policymakers in crafting policies

² <https://www.ssb.no/transport-og-reiseliv/landtransport/statistikk/bilparken/artikler/fire-av-fem-nye-biler-i-2022-var-elbiler>.

³ Several attitudes were systematically selected, prioritizing those that are crucial to understanding how transport policies, particularly congestion-charging policies, are accepted. Many attitudes (perceptions), such as effectiveness, fairness, personal freedom, environmental friendliness, clarity, and trust, have been identified in relevant literature. To ensure thoroughness, we also examined attitudes related to opposition to transportation policies, seeking out additional relevant items.

that align with public expectations and values. Moreover, the support for financially beneficial strategies underscores the economic aspect of policy acceptance, indicating that strategies offering financial incentives may be more favorably received.

Personal factors and beliefs, such as the importance of personal freedom of choice, environmental concerns, and a preference for high-tech solutions are also reported as correlates of a few transport policies (Gu et al., 2018; Steg, 2003). These factors emphasize the role of individual values, preferences, and optimism in policy acceptance. Policymakers could also use the knowledge about the importance of personal freedom, environmental concerns, and a preference for high-tech solutions to strike a balance between encouraging sustainable solutions and respecting individual concerns. Most of these attitudinal factors and perceptions are discussed in the context of push policies such as congestion charging and low-emission charging zones. Since the current study considers a wide range of policies including pull and emerging measures as well, we also investigate the role of other potential perceptions and attitudes such as physical activity, the need for social life and interactions through mobility, travel time considerations, financial benefits, and interest to high or low-tech solutions. As reported by Delbosc (2012), transport policies can influence well-being and life satisfaction. There are some individuals who may accept policies that do not restrict their physical activity during their daily mobility. For a significant portion of individuals, daily physical activity is not merely a routine but a fundamental aspect of their well-being. By understanding and respecting the abovementioned perceptions and attitudes, policymakers can design mobility interventions that seamlessly integrate with individuals' existing routines, minimizing disruptions and promoting positive health outcomes.

Additionally, people may not be in favor of policies that limit their social life and interactions with friends and family members. Social interactions contribute significantly to individuals' mental and emotional well-being, shaping the fabric of communities (Sandstrom and Dunn, 2014). Policies that inadvertently hinder these connections risk facing resistance and non-compliance. This awareness emphasizes the importance of crafting mobility solutions that not only address environmental concerns but also actively support and enhance social connectivity.

As a result of some policies, additional travel time and financial costs may be incurred, increasing their disutility. Policies imposing substantial time and financial burdens may encounter resistance, as they can significantly impact the overall travel experience (Frank et al., 2008). This recognition highlights the need for a delicate balance between achieving policy objectives and mitigating the potential disutilities imposed on individuals, ensuring that the costs associated with compliance do not outweigh the intended benefits.

Accordingly, we hypothesize that the aforementioned set of attitudinal variables and perceptions can play a role in shaping the acceptance of diverse transport policies. To further explore this, we profile distinct classes based on these attitudes and perceptions. Additionally, our exploration extends to understanding the variations among classes concerning socio-demographic factors (i.e., age, gender, and education), regional distinctions, and proximity to city centers.

The comprehensive assessment of attitudes and other variables as covariates in our study offers a fresh perspective on policy acceptance, encompassing attitudes (perceptions) and preference dimensions. An understanding of public attitudes/preferences provides policymakers with insights into how to craft transport policies that align with the attitudes (perceptions) and preferences of society. By bridging the gap between policy design and public expectations, our study promotes greater collaboration and acceptance of sustainable urban transportation systems. It contributes to the alignment of policies with the diverse needs and perspectives of the community, paving the way for effective and well-received solutions.

4. Method

4.1. Sample

In December 2023, a national survey was conducted among 1002⁴ Norwegian individuals (18 years old and older) via a self-reported online questionnaire. The survey method involved a randomized selection from a survey panel ("infact"⁵), ensuring representation across various regions, age groups, and genders within Norway. Data collection spanned all 11 counties in the country. All participants were duly informed about the voluntary nature of the survey⁶ and guaranteed the anonymity of their data.

The survey results indicate that 49 % of the participants identified as female. In terms of age distribution, 10.9 % fell within the 18–22 age bracket, 37.1 % were between 25 and 44, 34.6 % were within the 45–64 range, and the remaining respondents were older than 64. A comparative analysis was undertaken between the sample's demographics and the most recent official population statistics from Norway (Statistics Norway, 2023).⁷ Overall, the demographics of the sample closely mirrored those of the general population (see

⁴ The response rate is unknown as it was not provided by the panel company.

⁵ <https://www.infact.no/>.

⁶ The survey was part of the DRIVERS project. The project is financed by the Transport 2025 program from the Norwegian Research Council (Project number: 283354). <https://driversproject.wordpress.com/english-2/>.

⁷ In terms of educational representation, it seems that the survey's "panel" may have primarily focused on two overarching educational tiers: higher education (college/university graduates, especially those with Master's degrees and beyond) and lower educational attainment levels. Consequently, there is a likelihood of an overemphasis on individuals with advanced degrees, potentially skewing the sample, while simultaneously observing a significant underrepresentation of those with minimal educational backgrounds, such as individuals with primary school education. One possible cause of this issue is the fact that highly educated individuals are more likely to participate in panel studies compared to other demographic groups. Consequently, the data collected exhibits a bias towards individuals with higher levels of education, while those with primary school degrees are likely underrepresented in the sample. However, the focus of our analysis is primarily on distinguishing individuals with higher education (college and university) from those with lower educational attainment levels and does not extend to a more detailed examination.

Table 1). For instance, the percentage of females in the sample was consistent with the gender distribution of Norwegians over 16 years old, which is approximately 50 %. Furthermore, the sample's geographical distribution aligned with Norwegian population data. However, there is a minor deviation from the population, with Oslo being slightly overrepresented in the comparison. Of note, we had also suggested a question in the survey to measure income. However, due to the final Norwegian wording approved by the Panel, we assessed that the variable had low reliability and was not suited to be included in the analysis. The wording of the question about income lacked clarity on terms like “household,” “members,” and “tax,” making it challenging for participants to accurately calculate their household income. Additionally, the collected data did not seem to reflect an accurate representation, indicating participants may have found the question difficult to answer precisely. Hence, this influenced our decision not to include income as a variable in this study.

4.2. Measures

The items used in this study were part of a broader survey focused on assessing transport policies and advancements in mobility transition within Norway. Proficient researchers fluent in both Norwegian and English were responsible for developing and translating numerous validated English scales into Norwegian for the survey.

The level of acceptance regarding different transport policies/strategies was measured using a five-point Likert scale ranging from (1) completely not acceptable to (5) completely acceptable. As explained in **Table 2**, twenty policies/solutions were described to respondents to make the assessments easier and more understandable for participants. This description aimed at ensuring that respondents were provided with a well-defined set of policies, contributing to more informed and discerning evaluations.

Among the different policies mentioned earlier, twenty were selected for incorporation into the survey. The selection of these 20 policies was not arbitrary but rather the outcome of a thoughtful and collaborative brainstorming method involving local experts. For the brainstorm, six experts with backgrounds in transportation, technology, culture, and politics were invited, all of whom had extensive experience in public sector and university employment (with doctoral degrees). This brainstorming session gathered insights from individuals with expertise in transport policy, ensuring a diverse range of perspectives and considerations. The involvement of these experts ensured that the selected policies were not only relevant to the current context but also aligned with the historical trajectory of Norwegian transport policies. Policies with a significant historical footprint or those intimately familiar to the Norwegian population were retained for their enduring impact and the ease with which participants could engage with and evaluate them. For instance, policies like HOV lanes were not taken into consideration because local experts believed that this approach had not been a focal point for attention and practical implementation in Norway. The following question was asked for these policies: “In your opinion, to what extent is it acceptable to promote/develop each of the following strategies aimed at reducing energy use/ traffic emissions/congestion in urban transportation?”.

In the next section, different attitudes (the extent of agreement or disagreement) toward transport strategies aimed at reducing energy use/emissions/traffic congestion in urban transportation were assessed. A five-point Likert scale ranging from (1) strongly disagree to (5) strongly agree was used to measure these statements (see **Table 3**).

4.3. Analysis

4.3.1. PCA

A principal component analysis (PCA) is conducted to ascertain the uniform evaluation of transport policies by individuals. This analysis aims to identify several components (factors) that can distinguish policy categories, such as distinguishing between emerging policies and traditional policies. Eigenvalues were thoroughly examined, with a criterion set to retain principal components with eigenvalues surpassing 1, as suggested by Kaiser's Rule. This ensured that components selected for further analysis captured a meaningful proportion of the variance in the original data. Additionally, a scree plot was generated to visualize eigenvalue distribution, aiding in the determination of the optimal number of principal components to retain (**Abdi and Williams, 2010**). To enhance interpretability, an orthogonal rotation (Varimax) was applied to the loading scores, facilitating a clearer understanding of the relationship between variables and components. Furthermore, to assess the homogeneity of evaluations across distinct transport policy categories, the loading scores of retained components were scrutinized for substantive associations with specific policies. A threshold for substantive loading (i.e., loadings above 0.50) scores was set to identify policies that significantly contributed to each principal component, aiding in the categorization of policies into meaningful groups. The interpretability of the resulting components was assessed by considering the relevance of identified patterns to the overarching goals of our study.

4.3.2. Latent class analysis

By performing the latent class analysis, it is possible to classify unobserved subgroups of people and distinguish classes of acceptance/controversy patterns. LCA, as a probabilistic method, identifies unobserved (latent) subgroups in the population based on observed variables. This analysis is based on a conceptualization shown in **Fig. 1**. It is assumed that the indicators with regard to the level of acceptance of each policy are indicators of the classes of policies in the model. Thus, clustering is entirely determined by the (shared) heterogeneity among the indicators (Vermunt and Magidson, 2013). This part of the model, namely the measurement model, is solely responsible for determining the optimal number of latent classes (to be discussed shortly). Indicators were specified as ordinal, which means that ordinal regression models were used to capture the relationships between latent class variables and indicators.

As a further step, we profile the classes based on different attitudes, gender, age, educational level, region, and distance to CBD. It is possible to assume that these variables are the cause of latent class membership, and are therefore included in the class membership

Table 1
Sample characteristics (n = 1002).

Characteristic	Category	Sample (%)	Norway population (%)
Gender	Male	50.5	50.38
	Female	49.0	49.63
	Other	0.4	—
	Prefer not to disclose	0.1	—
Age (in years)	18—24	10.9	10.58
	25—44	37.1	34.08
	45—64	34.6	32.24
	65 +	17.6	23.09
Level of Education	Primary school	4.8	23.7
	High school	38.4	36.3
	College and university (bachelor)	33.3	25.3
	University (Master and higher)	21.5	11.6
	Other	2	3.2
Region	West	26.70	26.51*
	Oslo	16.80	12.90
	Southeast	36.50	38.07
	Mid Region	11.80	13.64
	North	8.20	8.88

* Population Statistics (2022).

Table 2
Evaluated transport policies/solutions in the survey.

Policy #	Description
Policy #1	<u>Maintaining today's Electric Vehicles (EVs) incentives</u> : tax and fee reductions for electric vehicles and financial support to purchase EVs.
Policy #2	<u>Public investments into Autonomous Vehicles</u> : self-driving cars and buses that can optimize routes and reduce energy consumption.
Policy #3	<u>Facilitate increased use of shared mobility services</u> : apps or digital platforms that make it easier to share vehicles if traveling in the same direction.
Policy #4	<u>Facilitate increased use of electric micro-mobility</u> : including electric bikes and scooters.
Policy #5	<u>Public financial support for the purchase of electric bicycles</u> .
Policy #6	<u>Public transit investments</u> : improving current buses, trams, subways, or trains for daily commuting.
Policy #7	<u>Better facilitation for active mobility</u> : expansion of bike lanes, better sidewalks, city infrastructure adapted to pedestrians, making cycling less risky and more practical.
Policy #8	<u>Telecommuting support</u> : working from home or remotely to avoid commuting altogether.
Policy #9	<u>Voluntarily organized car-free days</u> : organizing days where people are encouraged to voluntarily not use the car.
Policy #10	<u>Low Emission Zones (LEZs)</u> : establishing areas where only vehicles meeting specific emission standards are allowed to enter, incentivizing the use of cleaner vehicles.
Policy #11	<u>Park and Ride</u> : using park-and-ride facilities to combine car travel with public transit.
Policy #12	<u>Congestion charging schemes</u> : charging fees for vehicles entering congested city centers or busy roadways during peak hours to reduce traffic and energy consumption.
Policy #13	<u>Increased taxes and fees for polluting transport</u> : making it more expensive to travel with means of transport with high climate and environmental emissions.
Policy #14	<u>Subsidized public transit</u> : providing subsidies to make public transit more affordable and accessible, thereby encouraging its use.
Policy #15	<u>Restrictions on car parking</u> : making parking more expensive and reducing the number of parking spaces to make it less attractive to use private cars.
Policy #16	<u>Mobility credits</u> : some regions offer mobility credits or rewards for choosing sustainable transportation options, such as walking, biking, or using public transit.
Policy #17	<u>Public awareness campaigns</u> : running educational campaigns to raise awareness about the benefits of sustainable transportation and encourage behavior change.
Policy #18	<u>Proximity to amenities</u> : service and amenity offerings are located closer to where I live (e.g., daycare, school, recreational activities, shopping centers).
Policy #19	<u>Scrap and replace</u> : scrapping a gasoline or diesel-powered vehicle prematurely for a newer, more fuel-efficient, plug-in hybrid, or EV.
Policy #20	<u>Introduce public measures that restrict activities</u> : measures contributing to an increase in transportation needs (e.g., online shopping).

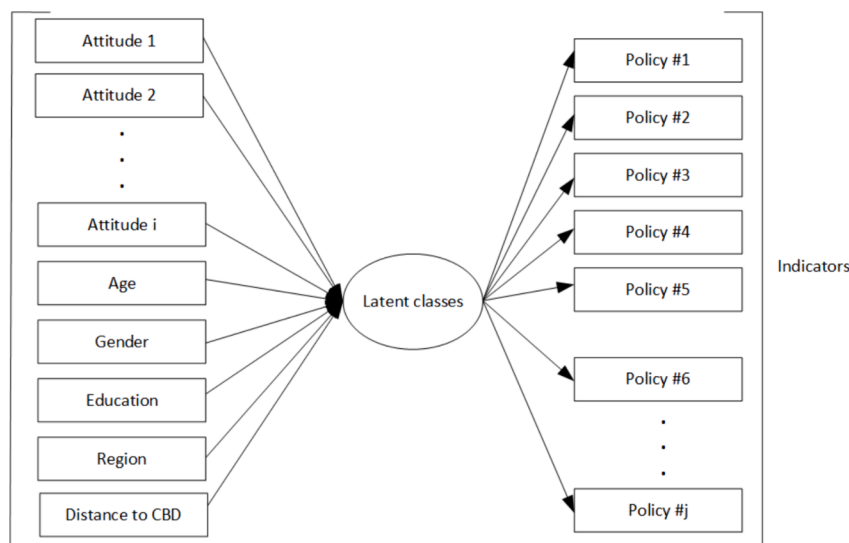
function, which comprises the structural component of the model. The (in)consistencies between the transport policies acceptance indicators can be better understood by profiling the classes based on these variables.

In the realm of latent class analysis, the primary aim is to pinpoint the most parsimonious model, characterized by the fewest latent classes, capable of effectively capturing the relationships among the indicators (Kroesen, 2019). Following the initial model, additional models were computed, ranging from 1 to 9 latent classes, to pinpoint the optimal model. To maintain limited differences between cluster sizes, we established a minimum cluster size equivalent to 8 % of the dataset (Ton et al., 2020). Table 4 employs the Bayesian

Table 3Attitudinal⁹ statements towards transport policies.

Attitude #	Statement
Attitude #1	The strategy should be <u>simple</u> and clear in its details.
Attitude #2	I <u>trust</u> policymakers/government with respect to such strategies.
Attitude #3	For me, the <u>effectiveness</u> of the strategy is very important before accepting a particular strategy.
Attitude #4	<u>Fairness</u> of the strategy is very important to me in accepting a particular strategy.
Attitude #5	I think a strategy should not limit my <u>freedom</u> to choose my own travel mode.
Attitude #6	I am in favour of <u>environmentally friendly</u> strategies.
Attitude #7	I prefer <u>high-tech solutions</u> (e.g., electric vehicles) over <u>low-tech solutions</u> (e.g., biking or walking).
Attitude #8	I support strategies that are <u>financially</u> beneficial to me.
Attitude #9	It is acceptable that strategies mean that I have to use more <u>active forms of transport</u> .
Attitude #10	The strategy should not limit my <u>social life and interactions</u> with my friends/peers and family members.
Attitude #11	The strategy should not result in <u>additional travel time</u> .

⁹ Among psychologists, not all of these would be categorized as attitudes; some items may pertain to various perceptions. Nevertheless, for the sake of simplicity and to avoid unnecessary conceptualization in this paper, we consistently use the term “attitude” when referring to these items.

**Fig. 1.** Latent class model conceptualization.

Information Criterion (BIC) as a yardstick to evaluate the fit of these models—a metric that strikes a balance between model fit and parsimony (Vermunt and Magidson, 2013). According to BIC statistics, the 6-class model emerges as the most optimal. Consequently, the results section will provide a comprehensive interpretation of this solution. All analyses were conducted with jamovi 2.3.21 ([The jamovi project, 2022](#)); a free, open, and R-based statistical software.

Table 4

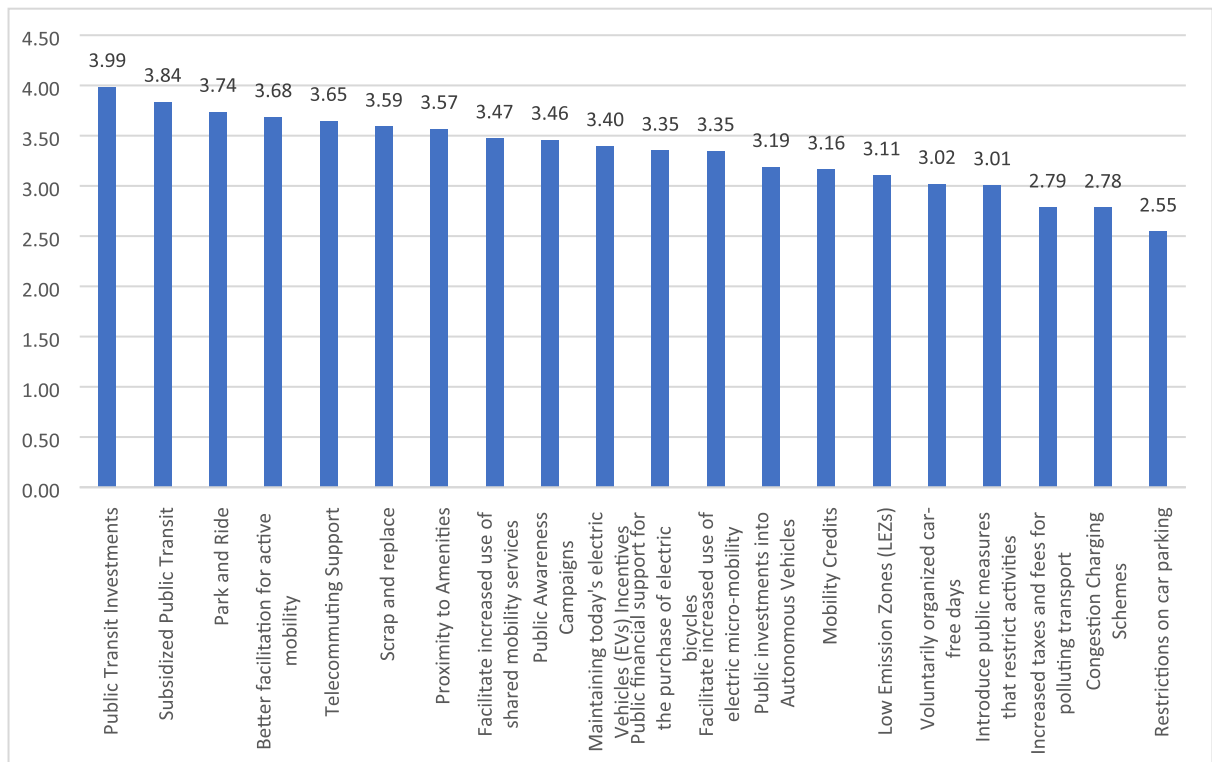
Fit of the latent class model.

Class	AIC	BIC	ABIC	CAIC	Log-likelihood	χ^2	G ²
1	46,749	50,324	48,011	51,052	−22647	7.86e + 14	32,044
2	46,799	50,373	48,061	51,101	−22671	2.99e + 14	32,094
3	46,761	50,335	48,023	51,063	−22652	3.07e + 16	32,056
4	46,833	50,407	48,095	51,135	−22688	1.80e + 16	32,127
5	47,113	50,687	48,375	51,415	−22829	2.31e + 16	32,408
6	46,723	50,297	47,985	51,025	−22633	1.61e + 16	32,017
7	46,787	50,361	48,049	51,089	−22666	2.47e + 16	32,082
8	46,946	50,520	48,208	51,248	−22745	2.50e + 16	32,241
9	46,796	50,370	48,058	51,098	−22670	2.03e + 14	32,091

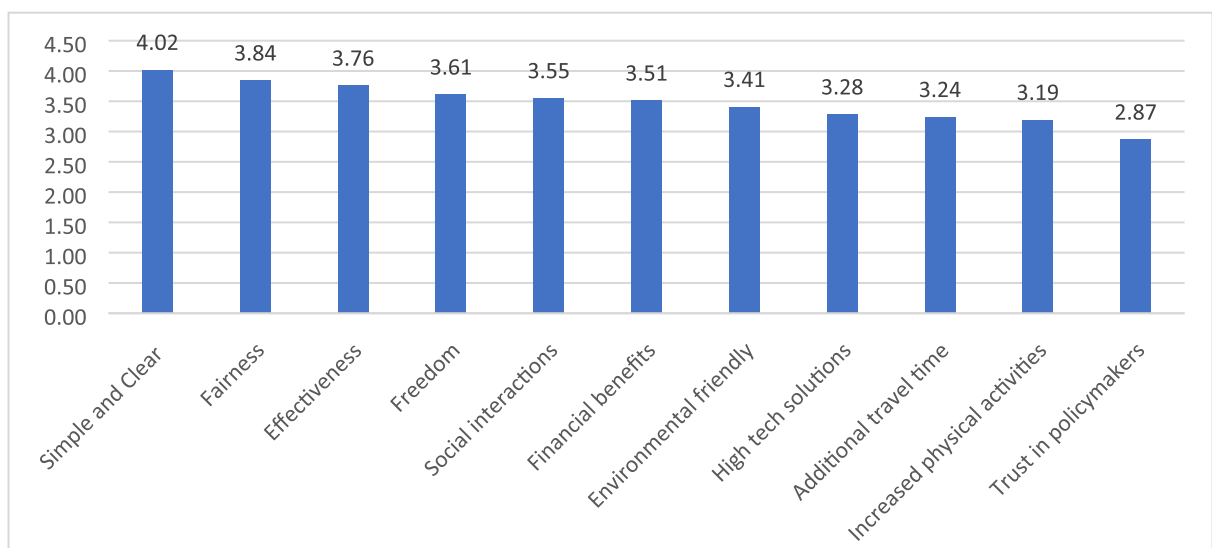
5. Analysis of results and discussion

5.1. Policies and attitudes rankings

Examining Fig. 2 reveals that among various transport policies, policy #6 (investment in public transport infrastructure), policy #14 (subsidizing public transport), park-and-ride solutions, and active transport improvements are widely accepted. Conversely, parking policy and congestion charging emerge as particularly controversial. In terms of attitudinal factors, simplicity, fairness, and



a) The score of transport policies



b) The score of attitudinal items

Fig. 2. The score of transport policies and attitudinal items.

effectiveness of transport policies receive the highest scores, underscoring their importance. In contrast, trust in policymakers registers the lowest score.

5.2. PCA results

The results of the PCA are presented in Table 5. The overall Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy yielded a highly satisfactory value of 0.95. Utilizing various criteria, including eigenvalues, three distinct components were identified in the analysis. The first component comprises nine policies, predominantly characterized by traditional pull strategies within travel demand management. In contrast, the second component encompasses six policies, predominantly featuring push measures that involve restricting car use in various ways. The final component incorporates the remaining policies, primarily showcasing emerging solutions such as electrification, automation, micro-mobility, and mobility credit schemes. Consequently, the identified factors can be delineated as follows: (i) “traditional pull policies”, (ii) “car-based push policies”, and (iii) “emerging policies”.

5.3. The results of latent class model

Table 6 displays the class profiles based on evaluations of transport policies, while Table 7 provides a detailed analysis of the classes by examining attitudinal variables and other covariates. Cross-tabulation of mean scores for PCA policy categories and classes is also shown in Table 8. In this cross-tabulation, for example, in class 1, the mean score of traditional pull policies is relatively high at 3.85, whereas car-based push policies score notably lower at 1.95, and emerging policies fall around the middle at 3.04. In general, the classes are highly interpretable.

Class 1 – *Supports traditional pull policies, strongly opposes car-based push policies, and is neutral about emerging policies.* The first class, comprising 18.23 % of the sample, consists of individuals who endorse traditional pull measures such as public transportation investment and subsidies, telecommuting, land-use policies, and support for active mobility. Simultaneously, they strongly object to car-based push policies, including congestion charging, low-emission zones, parking strategies, and taxation on polluting modes. Notably, this group remains neutral toward emerging policies such as electric vehicle incentives, investments in autonomous vehicles, micro-mobility modes, and e-bikes. Examining class profiles in attitudinal variables (Table 7), it appears that individuals in this class strongly advocate for policies that are simple, effective, and fair, without imposing restrictions on their freedom. Nevertheless, they express strong opposition to policies that encourage increased active transport, result in additional travel time, and diminish social interaction. Members of this class maintain a neutral stance on environmental issues, high-tech solutions, and financial incentives. This group exhibits no discernible gender disparity, and a predominant portion of its members belong to the older population (65 years and above).

Class 2 – *is neutral to all types of policies.* The second class, representing 9.57 % of the sample, is composed of individuals who consistently express neutrality toward all policy types, whether traditional pull, car-based push, or emerging policies. This group holds the potential to influence the acceptance or opposition to transport policies. Likewise, this group maintains a neutral stance across all attitudinal statements, underscoring a consistent alignment between their attitudes and behavioral intentions within this class. The majority hold lower educational degrees, with ages ranging from 35 to 44 years old. Additionally, women slightly outnumber men in this particular demographic.

Table 5
PCA results for the evaluations of transport policies.

Policy		Component		
		i	ii	iii
Policy #6	Public transit investments	0.812		
Policy #14	Subsidized public transit	0.771		
Policy #11	Park and ride	0.725		
Policy #18	Proximity to amenities	0.637		
Policy #7	Better facilitation for active mobility	0.631		
Policy #8	Telecommuting support	0.541		
Policy #17	Public awareness campaigns	0.537		
Policy #3	Facilitate increased use of shared mobility services	0.531		
Policy #19	Scrap and replace	0.521		
Policy #12	Congestion charging schemes		0.835	
Policy #15	Restrictions on car parking		0.831	
Policy #13	Increased taxes and fees for polluting transport		0.771	
Policy #10	Low Emission Zones (LEZs)		0.684	
Policy #9	Voluntarily organized car-free days		0.645	
Policy #20	Introduce public measures that restrict activities		0.519	
Policy #1	Maintaining today's electric vehicles (EVs) incentives			0.751
Policy #5	Public financial support for the purchase of electric bicycles			0.683
Policy #4	Facilitate increased use of electric micro-mobility			0.605
Policy #2	Public investments in Autonomous Vehicles			0.554
Policy #16	Mobility credits			0.529

(i) “traditional pull policies”, (ii) “car-based push policies”, and (iii) “emerging policies”.

Table 6
Class profiles.

Policy #	Indicator (policy)	Class Class size (%) Categories	1 18.23	2 9.57	3 9.09	4 25.44	5 15.68	6 21.99
Policy # 1	Maintaining today's electric Vehicles (EVs) incentives (%)	Completely not acceptable	15.0	1.0	67.0	0.4	9.0	2.7
		Not acceptable	18.3	0.0	7.7	5.0	27.7	6.4
		Neutral	21.7	90.7	6.6	21.6	39.4	10.5
		Acceptable	23.3	7.2	7.7	59.1	14.2	27.3
		Completely Acceptable	21.7	1.0	11.0	13.9	9.7	53.2
Policy # 2	Public investments in Autonomous Vehicles (%)	Completely not acceptable	21.1	0.0	60.4	1.5	3.9	5.0
		Not acceptable	16.7	2.1	7.7	7.3	29.7	4.1
		Neutral	30.6	96.9	26.4	39.0	35.5	19.5
		Acceptable	23.3	1.0	2.2	48.6	21.9	32.3
		Completely Acceptable	8.3	0.0	3.3	3.5	9.0	39.1
Policy # 3	Facilitate increased use of shared mobility services (%)	Completely not acceptable	1.1	3.1	48.4	0.0	6.5	0.9
		Not acceptable	7.2	1.0	8.8	1.5	23.2	1.8
		Neutral	47.2	93.8	30.8	27.0	41.9	9.5
		Acceptable	39.4	2.1	11.0	68.0	20.6	35.0
		Completely Acceptable	5.0	0.0	1.1	3.5	7.7	52.7
Policy # 4	Facilitate increased use of electric micro-mobility (%)	Completely not acceptable	6.1	0.0	61.5	1.2	9.0	0.0
		Not acceptable	11.7	0.0	11.0	0.8	29.0	4.5
		Neutral	36.7	93.8	22.0	30.5	41.9	16.8
		Acceptable	36.1	5.2	4.4	62.2	16.8	35.9
		Completely Acceptable	9.4	1.0	1.1	5.4	3.2	42.7
Policy # 5	Public financial support for the purchase of electric bicycles (%)	Completely not acceptable	11.7	0.0	67.0	0.8	11.6	1.4
		Not acceptable	10.6	0.0	11.0	8.9	24.5	10.0
		Neutral	28.3	89.7	9.9	27.4	29.7	13.6
		Acceptable	32.8	9.3	4.4	55.2	23.9	25.5
		Completely Acceptable	16.7	1.0	7.7	7.7	10.3	49.5
Policy # 6	Public transit investments (%)	Completely not acceptable	0.0	0.0	29.7	0.0	7.7	0.0
		Not acceptable	0.0	0.0	5.5	1.9	20.6	0.0
		Neutral	1.7	91.8	22.0	6.2	34.8	2.7
		Acceptable	46.7	6.2	23.1	69.1	23.9	14.5
		Completely Acceptable	51.7	2.1	19.8	22.8	12.9	82.7
Policy # 7	Better facilitation for active mobility (%)	Completely not acceptable	0.6	0.0	48.4	0.4	5.8	0.5
		Not acceptable	4.4	1.0	12.1	1.5	25.2	0.0
		Neutral	28.9	90.7	22.0	14.7	38.7	5.5
		Acceptable	43.9	6.2	13.2	66.8	23.2	26.8
		Completely Acceptable	22.2	2.1	4.4	16.6	7.1	67.3
Policy # 8	Telecommuting support (%)	Completely not acceptable	3.9	1.0	37.4	0.8	7.7	0.5
		Not acceptable	5.0	0.0	6.6	1.9	22.6	1.8
		Neutral	25.0	94.8	29.7	17.8	34.2	10.0
		Acceptable	37.8	4.1	12.1	71.0	25.2	33.6
		Completely Acceptable	28.3	0.0	14.3	8.5	10.3	54.1
Policy # 9	Voluntarily organized car-free days (%)	Completely not acceptable	31.1	0.0	78.0	2.7	11.6	2.7
		Not acceptable	28.3	5.2	6.6	13.5	33.5	6.4
		Neutral	26.7	94.8	6.6	28.2	29.7	17.3
		Acceptable	12.8	0.0	7.7	52.5	19.4	27.7
		Completely Acceptable	1.1	0.0	1.1	3.1	5.8	45.9
Policy # 10	Low Emission Zones (LEZs) (%)	Completely not acceptable	31.1	0.0	85.7	0.0	9.0	1.8
		Not acceptable	31.1	2.1	9.9	10.8	29.0	4.5
		Neutral	19.4	97.9	4.4	24.3	41.3	4.1
		Acceptable	15.6	0.0	0.0	59.8	15.5	42.3
		Completely Acceptable	2.8	0.0	0.0	5.0	5.2	47.3
Policy # 11	Park and Ride (%)	Completely not acceptable	0.6	0.0	37.4	0.4	3.2	0.5
		Not acceptable	1.1	0.0	11.0	1.2	23.2	0.5
		Neutral	18.9	96.9	20.9	15.4	34.2	7.3
		Acceptable	48.9	3.1	19.8	72.6	30.3	38.6
		Completely Acceptable	30.6	0.0	11.0	10.4	9.0	53.2

(continued on next page)

Table 6 (continued)

Policy #	Indicator (policy)	Class Class size (%) Categories	1 18.23	2 9.57	3 9.09	4 25.44	5 15.68	6 21.99
Policy # 12	Congestion charging schemes (%)	Completely not acceptable	53.9	1.0	87.9	2.7	12.9	6.4
		Not acceptable	28.9	6.2	1.1	22.4	31.6	10.0
		Neutral	10.0	89.7	4.4	32.4	29.0	17.7
		Acceptable	6.1	3.1	4.4	40.9	21.9	31.4
		Completely Acceptable	1.1	0.0	2.2	1.5	4.5	34.5
Policy # 13	Increased taxes and fees for polluting transport (%)	Completely not acceptable	52.8	3.1	82.4	3.5	14.2	6.4
		Not acceptable	35.6	3.1	5.5	22.0	34.2	9.1
		Neutral	5.0	89.7	7.7	35.5	25.2	12.7
		Acceptable	5.6	4.1	3.3	36.3	18.7	35.0
		Completely Acceptable	1.1	0.0	1.1	2.7	7.7	36.8
Policy # 14	Subsidized public transit (%)	Completely not acceptable	1.7	0.0	40.7	0.0	5.2	0.5
		Not acceptable	2.8	3.1	12.1	4.2	21.3	0.9
		Neutral	4.4	91.8	17.6	15.4	38.7	6.4
		Acceptable	31.1	4.1	14.3	59.8	25.8	23.6
		Completely Acceptable	60.0	1.0	15.4	20.5	9.0	68.6
Policy # 15	Restrictions on car parking (%)	Completely not acceptable	73.9	3.1	91.2	1.9	12.9	13.2
		Not acceptable	24.4	8.2	5.5	35.9	32.3	15.0
		Neutral	0.6	87.6	3.3	29.7	32.3	17.3
		Acceptable	1.1	1.0	0.0	32.4	13.5	23.6
		Completely Acceptable	0.0	0.0	0.0	0.0	9.0	30.9
Policy # 16	Mobility credits (%)	Completely not acceptable	29.4	2.1	89.0	0.0	7.1	0.5
		Not acceptable	14.4	4.1	2.2	7.7	36.8	5.0
		Neutral	27.8	90.7	2.2	33.6	30.3	11.8
		Acceptable	23.9	2.1	3.3	54.8	17.4	32.3
		Completely Acceptable	4.4	1.0	3.3	3.9	8.4	50.5
Policy # 17	Public awareness campaigns (%)	Completely not acceptable	6.7	0.0	56.0	0.0	9.0	0.5
		Not acceptable	6.7	1.0	14.3	0.8	25.8	0.9
		Neutral	51.1	91.8	22.0	25.9	34.8	6.8
		Acceptable	30.0	7.2	5.5	69.9	20.6	31.4
		Completely Acceptable	5.6	0.0	2.2	3.5	9.7	60.5
Policy # 18	Proximity to amenities (%)	Completely not acceptable	3.3	0.0	50.5	0.0	4.5	0.9
		Not acceptable	6.7	2.1	14.3	1.9	34.8	1.8
		Neutral	30.6	96.9	16.5	18.1	34.2	5.0
		Acceptable	41.1	0.0	14.3	70.3	21.3	31.4
		Completely Acceptable	18.3	1.0	4.4	9.7	5.2	60.9
Policy # 19	Scrap and replace (%)	Completely not acceptable	6.1	0.0	49.5	0.0	7.1	0.5
		Not acceptable	5.0	2.1	9.9	6.2	26.5	1.4
		Neutral	21.7	91.8	23.1	18.5	35.5	7.7
		Acceptable	41.7	5.2	12.1	68.3	21.3	28.2
		Completely Acceptable	25.6	1.0	5.5	6.9	9.7	62.3
Policy # 20	Introduce public measures that restrict activities (%)	Completely not acceptable	21.1	1.0	73.6	1.5	8.4	6.8
		Not acceptable	30.6	1.0	11.0	12.7	24.5	8.6
		Neutral	31.1	92.8	14.3	43.2	37.4	19.1
		Acceptable	11.1	4.1	1.1	39.0	20.6	35.0
		Completely Acceptable	6.1	1.0	0.0	3.5	9.0	30.5

Class 3 – *Strongly opposes all types of policies*. The third class, accounting for 9.09 % of the sample, is characterized by individuals who vehemently oppose all types of policies. Remarkably, this group extends its strong opposition even to pull measures. In the realm of attitudes, this group exhibits robust expectations that policies should fulfill various criteria, including clarity, effectiveness, and fairness. Moreover, they hold concerns that such policies might yield adverse consequences for them, such as increased physical activities, additional travel time, and reduced social interactions. Notably, they maintain a neutral stance regarding financial benefits and the technological orientation of the policy. This group skews towards a higher proportion of men, and the members tend to be relatively older.

Class 4 – *supports moderately all policies but opposes parking policies*. The fourth class, making up 25.44 % of the sample, comprises individuals who exhibit moderate support for various policy types, encompassing pull, car-based push, and emerging strategies. Nevertheless, they hold a negative opinion on measures such as increasing parking costs and reducing the number of parking spaces. In

Table 7

Covariate distributions of the classes.

	Class	1	2	3	4	5	6
	Class size (%)	18.23	9.57	9.09	25.44	15.68	21.99
Covariate	Categories						
Simple and clear (Attitude #1) (%)	strongly disagree	0.0	0.0	4.4	0.0	5.8	1.4
	disagree	1.1	1.0	3.3	3.9	14.8	1.4
	neither disagree nor agree	11.7	58.8	33.0	12.7	27.1	13.6
	agree	40.6	24.7	20.9	52.1	32.9	30.0
	strongly agree	46.7	15.5	38.5	31.3	19.4	53.6
Trust (Attitude #2) (%)	strongly disagree	33.9	8.2	57.1	4.6	13.5	10.9
	disagree	28.9	10.3	13.2	17.4	31.6	17.3
	neither disagree nor agree	22.2	67.0	19.8	30.9	24.5	19.5
	agree	12.8	13.4	4.4	40.2	20.0	29.1
	strongly agree	2.2	1.0	5.5	6.9	10.3	23.2
Effectiveness (Attitude #3) (%)	strongly disagree	6.1	1.0	19.8	0.8	7.7	1.8
	disagree	5.0	3.1	7.7	6.2	14.8	4.5
	neither disagree nor agree	19.4	68.0	19.8	19.7	37.4	14.1
	agree	35.6	21.6	11.0	50.2	21.9	32.7
	strongly agree	33.9	6.2	41.8	23.2	18.1	46.8
Fairness (Attitude #4) (%)	strongly disagree	2.2	1.0	14.3	0.8	9.7	1.8
	disagree	4.4	6.2	1.1	4.2	14.8	3.2
	neither disagree nor agree	14.4	64.9	31.9	21.6	32.3	9.1
	agree	35.0	21.6	17.6	49.4	29.7	33.2
	strongly agree	43.9	6.2	35.2	23.9	13.5	52.7
Freedom (Attitude #5) (%)	strongly disagree	1.7	0.0	15.4	2.3	10.3	11.4
	disagree	3.9	5.2	2.2	13.9	16.1	15.0
	neither disagree nor agree	14.4	69.1	4.4	33.6	26.5	22.3
	agree	27.8	18.6	6.6	35.1	25.8	26.8
	strongly agree	52.2	7.2	71.4	15.1	21.3	24.5
Environmentally friendly (Attitude #6) (%)	strongly disagree	8.9	3.1	38.5	1.9	14.8	0.5
	disagree	15.0	9.3	16.5	10.4	21.3	6.8
	neither disagree nor agree	35.6	66.0	26.4	27.8	29.0	11.8
	agree	31.1	14.4	7.7	42.5	25.8	31.8
	strongly agree	9.4	7.2	11.0	17.4	9.0	49.1
High-tech solutions (Attitude #7) (%)	strongly disagree	6.7	1.0	33.0	1.9	9.7	4.1
	disagree	10.0	6.2	8.8	8.5	12.3	9.5
	neither disagree nor agree	52.2	74.2	38.5	39.0	51.0	26.8
	agree	25.6	15.5	13.2	43.6	16.8	26.8
	strongly agree	5.6	3.1	6.6	6.9	10.3	32.7
Financially beneficial (Attitude #8) (%)	strongly disagree	5.6	1.0	11.0	0.8	5.8	6.8
	disagree	5.0	1.0	3.3	12.0	19.4	11.8
	neither disagree nor agree	33.3	66.0	34.1	37.5	38.1	23.2
	agree	29.4	22.7	18.7	39.0	21.3	24.5
	strongly agree	26.7	9.3	33.0	10.8	15.5	33.6
More active forms of transport (Attitude #9) (%)	strongly disagree	31.1	2.1	69.2	2.3	14.8	3.6
	disagree	15.6	10.3	14.3	7.7	19.4	5.5
	neither disagree nor agree	26.7	73.2	12.1	26.6	36.8	11.8
	agree	20.0	11.3	2.2	48.3	20.0	32.3
	strongly agree	6.7	3.1	2.2	15.1	9.0	46.8
Social life and interactions (Attitude #10) (%)	strongly disagree	3.3	8.2	5.5	5.1	7.7	16.4
	disagree	5.0	11.3	3.3	19.3	18.7	19.1
	neither disagree nor agree	9.4	68.0	15.4	27.4	34.2	15.0
	agree	20.0	8.2	2.2	33.2	20.6	23.2
	strongly agree	62.2	4.1	73.6	15.1	18.7	26.4
Additional travel time (Attitude #11) (%)	strongly disagree	1.1	1.0	3.3	4.6	7.7	24.1
	disagree	8.9	11.3	3.3	33.6	18.7	31.8
	neither disagree nor agree	23.3	71.1	7.7	32.4	29.7	15.5
	agree	31.7	11.3	12.1	22.4	29.0	17.3
	strongly agree	35.0	5.2	73.6	6.9	14.8	11.4
Gender (%)	Man	47.8	40.2	62.6	49.8	54.2	50.5
	Woman	51.7	57.7	37.4	49.8	45.8	49.1
	Other	0.6	1.0	0.0	0.4	0.0	0.5
	Prefer not to disclose	0.0	1.0	0.0	0.0	0.0	0.0
Age (%)	18–24	5.60	10.30	9.90	6.60	27.10	9.50
	25–34	11.70	10.30	4.40	19.30	23.90	20.00
	35–44	15.60	30.90	17.60	19.70	12.90	27.30
	45–54	22.20	24.70	19.80	23.60	12.90	15.90
	55–64	20.00	11.30	19.80	13.90	10.30	14.10
Education (%)	65+	25.00	12.40	28.60	17.00	12.90	13.20
	Primary school	4.40	9.30	9.90	3.10	3.20	4.10

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Table 7 (continued)

	Class	1	2	3	4	5	6
Region (%)	High school	41.70	52.60	36.30	37.80	40.00	30.00
	University degree	50.00	37.10	51.70	56.70	55.40	65.00
	Other	3.90	1.00	2.20	2.30	1.30	0.90
	Mid Region	12.8	7.2	16.5	10.4	8.4	15.0
	North	10.0	5.2	11.0	6.2	9.0	8.6
	Oslo	11.7	8.2	16.5	15.8	27.1	18.6
	Southwest	39.4	50.5	36.3	36.3	29.7	33.2
Distance to CBD (%)	West	26.1	28.9	19.8	31.3	25.8	24.5
	Living in the CBD	8.9	9.3	12.1	19.3	25.2	15.5
	0–4 km	40.6	34.0	33.0	37.8	30.3	36.4
	5–9 km	23.9	22.7	20.9	23.9	20.6	19.1
	10–14 km	16.1	13.4	14.3	8.1	14.2	12.3
	15–19 km	2.2	5.2	2.2	4.6	3.2	6.8
	20–24 km	2.8	7.2	5.5	2.3	3.2	4.1
	25–29 km	1.1	1.0	4.4	2.7	2.6	2.7
	30 km and more	4.4	7.2	7.7	1.2	0.6	3.2

Table 8

Cross-tabulation of mean scores for PCA policy categories and latent policy classes.

Policy categories	Class	1	2	3	4	5	6
PCA components (Mean score on a scale of 1–5)	Traditional pull policies	3.85	3.03	2.32	3.88	3.04	4.52
	Car-based push policies	1.95	2.95	1.31	3.25	2.78	3.86
	Emerging policies	3.04	3.04	1.69	3.62	2.89	4.14

the realm of attitudes, it seems that this group is willing to make sacrifices, such as accepting additional travel time or policies that promote more active travel. They demonstrate greater openness to high-tech solutions and exhibit stronger trust in policymakers compared to classes 1–3 and 5. Unlike other classes, they do not strongly insist on policies respecting their freedom and fairness. Overall, this group displays a relatively flexible attitude toward the implementation of transport policies. There is no distinct gender gap within this group, and individuals typically possess university degrees. The majority fall within the middle age range of 45 to 54 years old.

Class 5 – *is almost neutral to traditional pull policies and emerging policies but moderately opposes car-based push policies*. The fifth class, representing 15.68 % of the sample, includes individuals who exhibit almost neutral stances toward traditional pull and emerging policies. However, they display a moderate level of rejection toward car-based push policies. In terms of attitudes, this group appears to adopt a neutral stance, neither strongly agreeing nor disagreeing with many attitudinal items, with the exceptions of simplicity of policies and trust in policymakers. They exhibit a moderate level of distrust in policymakers and place importance on the simplicity and clarity of transport policies. Men have a slightly larger representation in this group, and individuals within it are generally younger, holding university degrees.

Class 6 – *strongly supports all types of policies*. The final class, comprising 21.99 % of the sample, is comprised of individuals who strongly endorse a wide range of policies, encompassing pull, car-based push, and emerging strategies. This group is even notably supportive of push measures. Compared to other classes, individuals in this group hold the most positive environmental attitudes. They also express a strong expectation that policies should meet multiple requirements, including simplicity, effectiveness, and fairness. Additionally, this group exhibits a strong interest in high-tech strategies. They are also prepared to make sacrifices, such as sacrificing travel time or transitioning to more active forms of transport, following the implementation of such policies. We did not identify a gender gap in this group. Notably, individuals in this category exhibit significantly higher levels of education compared to other cohorts, and they fall within the mid-age range of 35 to 44 years old.

Regarding the respondents' residential regions (whether they reside in the North, Southeast, West, the central part of the country, or in the capital), we did not observe significant variations across different classes. The majority of participants in the study are also situated in urban areas, closer to city centers, as opposed to residing in rural or remote areas.

6. Conclusion, discussion, and implications

The current study aimed to comprehensively evaluate public opinions on various transport policies using a random and representative Norwegian-population-based sample ($n = 1002$). The investigation sought to identify attitudinal variables and perceptions associated with these policies, spanning traditional pull measures to emerging solutions. Employing a two-fold approach, we utilized PCA to identify homogeneously evaluated policy categories and an LCA to discern classes of acceptance and controversy.

First, we identified three distinct components of public evaluations of transport policies: “traditional pull policies” focusing on non-restrictive strategies such as incentives for public transport; “car-based push policies” focusing on actively limiting car use; and “emerging policies” focusing on innovative technologies such as electrification and automation. The three-dimensional categorization reveals distinct dimensions of policy preferences, providing policymakers and researchers with a comprehensive framework to

navigate the complex landscape of transport policies.

Second, The LCA analysis revealed distinct patterns within the sampled population, offering insights for policymakers. Six identified classes showcase diverse preferences and attitudes, each carrying implications for the development and implementation of effective transport policies. It is important to note that policies cannot be tailored to the individual groups' preferences. However, policymakers can use the identified preferences to make more informed decisions as they create awareness of issues that will likely cause resistance or support within different segments of the population.

One noteworthy pattern emerges from a class that strongly supports traditional pull policies while opposing car-based push measures. This suggests a segment of the population that favors established, straightforward policies that enhance public transportation without imposing restrictions on personal car use. Policymakers should recognize the importance of maintaining and enhancing traditional transport solutions while addressing concerns related to more restrictive measures. This class is characterized by a preference for simple, effective, and fair policies without restricting personal freedom. Members are typically older individuals.

Another key finding involves a group that consistently expresses neutrality towards all policy types. The neutrality of this class indicates that transport is not a topic that all citizens actively engage with. Based on this, policymakers should be aware that the success of policies also relies on active efforts to engage the public in transport issues and that there is a need to actively facilitate public debate on the crucial role of transport in achieving climate emission reduction. The class thus also holds the potential to significantly influence overall acceptance or opposition to transport policies by being tipped in either direction. Policy makers could engage with this group to understand their concerns and motivations, tailoring intervention strategies to address the unique perspectives within this neutral stance and how their travel behaviour can become better aligned with sustainability objectives. This group consists mainly of individuals with lower educational degrees in the age range of 35 to 44, with a slight majority of women.

Challenges arise from a class that strongly opposes all types of policies, including traditional pull measures. This class exhibits robust expectations and concerns about policy impacts, and it is skewed towards a higher proportion of men, with relatively older members. Policymakers need to develop targeted strategies to address concerns and highlight the benefits of such policies. Employing qualitative studies to understand the root causes of resistance and the underlying mobility practices within this class is crucial for navigating controversies and mobilizing support for transport transitions. Drawing on such qualitative insights, there might be potential for exploring more targeted policies for this group, for instance, policies tailored for older segments of the population that directly address mobility concerns related to old age and that can ease their transition to low-carbon solutions. The strong opposition to all policies can also indicate that the cause of resistance is linked to issues beyond the transport domain, like trust in policy-making processes. Facilitating participation from these groups in policy development could thus be crucial for cultivating higher levels of trust that can positively influence policy acceptance.

Flexibility is evident in a group willing to make sacrifices, open to high-tech solutions, and shows trust in policymakers. While this group show support for most policies, they still show reluctance towards parking measures. Members typically possess university degrees and fall within the middle age range of 45 to 54. Policymakers could leverage this flexibility to explore innovative and adaptive solutions that align with changing preferences. High-tech solutions and advancements could find greater acceptance within this flexible class, fostering openness to technological interventions in transport policies.

The nuanced stance of a group valuing simplicity and clarity in transport policies, while also valuing fairness, suggests the benefit of clear and transparent policy designs with predictable outcomes. This group exhibits almost neutral stances toward pull and emerging policies but moderately opposes car-based push policies. This group predominantly comprises of younger individuals with university degrees. This group's preferences indicate that policymakers should be aware of the benefits of policy designs that can be easily understood by laypersons and that produce demonstrable outcomes. Additionally, the stated preferences indicate that policies must not only be justified based on their potential to reduce emissions, but the wider socio-economic effects also need to be assessed and viewed as an essential aspect of how citizens evaluate policy solutions.

Lastly, the environmental advocacy observed in a group that strongly supports a wide range of policies, including emerging solutions, underscores the importance of integrating sustainable practices into transport policies. This group strongly supports all policy types, including push measures and emerging solutions. This environmentally conscious group, characterized by higher education levels, advocates for policies meeting multiple criteria and is prepared to make sacrifices for their implementation. Policymakers should consider measures that promote eco-friendly transportation alternatives and address environmental concerns, aligning with the positive environmental attitudes within this group.

In sum, the class preferences show how transport policies link to a broad set of concerns that calls for a polycentric and multi-level governance approach. This, of course, does not mean that policymakers can simply tailor policies to cater for the concerns of all these groups. However, it clearly points to the merit of an approach that goes beyond a focus on single policies to an approach anchored in broader policy mixes (Hössinger et al., 2023). Rogge and Reichardt (2016) note that policy mixes consist of elements in the form of strategies (objectives and plans), alongside concrete policy instruments. These tend to be developed through policymaking and implementation processes. In sum, such mixes can e.g. be characterized in terms of consistency, coherence, or credibility. Our results point towards the existence of different groups and interests that should be able to influence the policy process, while also pointing towards relationships that might strengthen the legitimacy of policy mixes. An example of this would be combining parking restrictions with strong investments in public transport. As highlighted in previous research, developing holistic policy mixes that aim to counterbalance side effects from contemporaneous policies is an effective way of addressing such interlinked concerns (Wang et al., 2022; May and Roberts, 1995; May et al., 2005).

In addition, the overall distribution of support and resistance to the selected policies and attitudinal statements shows important trends. The study found that there is generally strong support for public transport-based policies, indicating a potential shift towards increased use of public transport if the services are improved. The analysis suggests that investing in public transport infrastructure and

subsidising ticket prices are likely to be popular policies with little resistance among the general public. However, the study also found that there is generally moderate to high resistance to car-based push policies, particularly parking restrictions.

These observations align with the public discourse on transport transitions in Norway, which has been characterized by heated debates about parking restrictions. Although the media tends to portray this as a polarised issue between public transport proponents and car proponents, this study shows that many people support both. That is, dispositions for high acceptance of public transport policies and resistance towards car use restrictions co-exist in many of the groups identified. This suggests a strong need to focus on the phase-in of improved public transport alternatives in combination with targeted phase-out strategies for private car use which can support the transition for people that rely heavily on private vehicles. If combined with highly valued policy characteristics, like simplicity, effectiveness, and fairness, this focus appears as a key strategy for policymakers. Importantly, the acceptance of parking policies has been shown to be linked with perceptions of benefits and recent studies have shown progress toward increasing levels of public acceptance of most parking policies (Kirschner and Lanzendorf, 2020). This highlights the need for policies that show a clear focus on how vacant space generated from parking restrictions can benefit urban planning processes and create added value for citizens. However, there is still a strong need for future research to better understand the contextual factors that shape attitudes towards parking policies and how these can be addressed through more effective, but fair, policy measures.

In conclusion, the diverse patterns identified within the population highlight the need for a comprehensive approach to developing transport policies. For the transition towards more sustainable transport systems, the analysis shows potential for more radical transport policies compared to today's policy landscape. As an example, when combined classes 4 and 6 aggregate 46.43 % of the sample which supports most policies, and importantly, show willingness to compromise aspects like travel time and transfer to more active mobility to contribute to more sustainable transport systems. However, the results also indicate that finding a compatible way for all groups might not be likely. Policymakers should strive to balance between traditional and innovative solutions, tailoring communication strategies to address concerns, and promoting sustainability in line with the varied preferences and attitudes observed. By recognizing and addressing these patterns, policymakers can enhance the acceptance and effectiveness of transport policies among the public. Nevertheless, despite such efforts, controversy over policy pathways, particularly regarding car use, will likely arise. Rather than to be reluctant and shy away from potentially controversial policies, policymakers thus need to build improved capacity for handling controversy in policy making processes to achieve the overarching objective of promoting more sustainable transport systems.

The study was not without limitations. We acknowledge that our study employs generic policy descriptions, which may not fully capture the nuances needed for meaningful policy direction. This approach assumes that relative preferences between any pair of policy options remain constant across all possible levels of those options, implying constant marginal rates of substitution. Consequently, the data collected can provide a first-order understanding of relative preferences. For more precise policy development, detailed information on specific measures, including their levels and rates of change, is necessary. We suggest that future research should aim to incorporate more detailed and specific policy descriptions to better inform policy decisions.

We relied on general attitudes towards transport policies. Future research endeavors could focus on cultivating policy-specific attitudes to more precisely discern acceptance classes. However, we maintain that general attitudes still offer valuable insights into various policy preferences. Exploring the cross-differences among different attitudinal aspects, such as between effectiveness and fairness, could shed light on the factors more or less influencing acceptance or opposition within policy classifications.

The policies examined in this study pertained to energy, emissions, and congestion-related strategies in Norway. It is noteworthy that other nations may either adopt, augment, or eliminate specific policies based on their historical context and future plans. Conducting comparative studies across diverse countries could unveil varying acceptance behaviors and contribute to mapping global trends in transport policies. Panel analyses can also offer additional insights into changes in acceptance over time, a dimension not explored in our cross-sectional study design.

CRediT authorship contribution statement

Milad Mehdizadeh: Writing – review & editing, Writing – original draft, Visualization, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Gisle Solbu:** Writing – review & editing, Resources, Project administration, Investigation, Funding acquisition, Data curation. **Christian A. Klöckner:** Validation, Supervision, Resources, Project administration, Funding acquisition. **Tomas Moe Skjølsvold:** Writing – review & editing, Validation, Resources, Project administration, Funding acquisition.

Declaration of competing interest

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

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References

- Abdi, H., Williams, L.J., 2010. Principal component analysis. *Wiley Interdiscip. Rev. Comput. Stat.* 2 (4), 433–459.
- Aguilera, A., Cacciari, J., 2020. Living with fewer cars: review and challenges on household demotorization. *Transp. Rev.* 40 (6), 796–809.
- Aziz, H.A., Ukkusuri, S.V., Romero, J., 2015. Understanding short-term travel behavior under personal mobility credit allowance scheme using experimental economics. *Transp. Res. Part D: Transp. Environ.* 36, 121–137.
- Bakaki, Z., Bernauer, T., 2017. Do global climate summits influence public awareness and policy preferences concerning climate change? *Environmental Politics* 26 (1), 1–26.
- Banister, D., 2005. *Unsustainable transport: city transport in the new century*. Taylor & Francis.
- Cabane, A., Zingoni de Baro, M.E., Newman, P., 2020. Biophilic streets: a design framework for creating multiple urban benefits. *Sustainable Earth* 3 (1), 1–17.
- Cassetta, E., Marra, A., Pozzi, C., Antonelli, P., 2017. Emerging technological trajectories and new mobility solutions. A large-scale investigation on transport-related innovative start-ups and implications for policy. *Transp. Res. A Policy Pract.* 106, 1–11.
- Cools, M., Brijs, K., Tormans, H., Moons, E., Janssens, D., Wets, G., 2011. The socio-cognitive links between road pricing acceptability and changes in travel-behavior. *Transp. Res. A Policy Pract.* 45 (8), 779–788.
- Delbosc, A., 2012. The role of well-being in transport policy. *Transp. Policy* 23, 25–33.
- Dugan, A., Mayer, J., Thaller, A., Bachner, G., Steininger, K.W., 2022. Developing policy packages for low-carbon passenger transport: A mixed methods analysis of trade-offs and synergies. *Ecol. Econ.* 193, 107304.
- Faisal, A., Kamruzzaman, M., Yigitcanlar, T., Currie, G., 2019. Understanding autonomous vehicles. *J. Transp. Land Use* 12 (1), 45–72.
- Farda, M., Balijepalli, C., 2018. Exploring the effectiveness of demand management policy in reducing traffic congestion and environmental pollution: Car-free day and odd-even plate measures for Bandung city in Indonesia. *Case Studies on Transport Policy* 6 (4), 577–590.
- Frank, L., Bradley, M., Kavage, S., Chapman, J., Lawton, T.K., 2008. Urban form, travel time, and cost relationships with tour complexity and mode choice. *Transportation* 35 (1), 37–54.
- Goodwin, P., 1999. Transformation of transport policy in Great Britain. *Transp. Res. A Policy Pract.* 33 (7–8), 655–669.
- Gu, Z., Liu, Z., Cheng, Q., Saberi, M., 2018. Congestion pricing practices and public acceptance: A review of evidence. *Case Studies on Transport Policy* 6 (1), 94–101.
- Haugen, K., Vilhelmsen, B., 2013. The divergent role of spatial access: The changing supply and location of service amenities and service travel distance in Sweden. *Transp. Res. A Policy Pract.* 49, 10–20.
- Haugland, B.T., 2023. The future is present: Prefiguration in policy and technology experimentation. *Environ. Innov. Soc. Trans.* 48, 100750.
- Henry, G.T., Gordon, C.S., 2003. Driving less for better air: Impacts of a public information campaign. *J. Policy Anal. Manage.* 22 (1), 45–63.
- Hoerler, R., Stoiber, P., Del Duce, A., 2023. Push and pull strategies to increase the uptake of small electric vehicles. *Transp. Res. Part D: Transp. Environ.* 116, 103638.
- Hössinger, R., Peer, S., Juschten, M., 2023. Give citizens a task: An innovative tool to compose policy bundles that reach the climate goal. *Transp. Res. A Policy Pract.* 173, 103694.
- Hrelja, R., Rye, T., 2023. Decreasing the share of travel by car. Strategies for implementing 'push' or 'pull' measures in a traditionally car-centric transport and land use planning. *Int. J. Sustain. Transp.* 17 (5), 446–458.
- Huang, Y., Ng, E.C., Zhou, J.L., Surawski, N.C., Chan, E.F., Hong, G., 2018. Eco-driving technology for sustainable road transport: A review. *Renew. Sustain. Energy Rev.* 93, 596–609.
- Huber, R.A., Wicki, M., 2021. What explains citizen support for transport policy? the roles of policy design, trust in government and proximity among Swiss citizens. *Energy Res. Soc. Sci.* 75, 101973.
- Keith, D.W., Farrell, A.E., 2003. Rethinking hydrogen cars. *Science* 301 (5631), 315–316.
- Kirschner, F., Lanzendorf, M., 2020. Support for innovative on-street parking policies: Empirical evidence from an urban neighborhood. *J. Transp. Geogr.* 85, 102726.
- Kroesen, M., 2019. Is active travel part of a healthy lifestyle? Results from a latent class analysis. *J. Transp. Health* 12, 42–49.
- Li, Z., Hensher, D.A., 2012. Congestion charging and car use: A review of stated preference and opinion studies and market monitoring evidence. *Transp. Policy* 20, 47–61.
- May, A.D., Roberts, M., 1995. The design of integrated transport strategies. *Transp. Policy* 2 (2), 97–105.
- Mehdizadeh, M., Shariat-Mohaymany, A., 2020. Who are more likely to break the rule of congestion charging? Evidence from an active scheme with no referendum voting. *Transp. Res. A Policy Pract.* 135, 63–79.
- Mehdizadeh, M., Shariat-Mohaymany, A., 2021. Who are less likely to vote for a low emission charging zone? Attitudes and adoption of hybrid and electric vehicles. *Transp. Res. A Policy Pract.* 146, 29–43.
- Rogge, K.S., Reichardt, K., 2016. Policy mixes for sustainability transitions: An extended concept and framework for analysis. *Res. Policy* 45 (8), 1620–1635.
- Ryghaug, M., Skjolsvold, T.M., 2023. How policies and actor strategies affect electric vehicle diffusion and wider sustainability transitions. *Proc. Natl. Acad. Sci.* 120 (47) e2207888119.
- Sandstrom, G.M., Dunn, E.W., 2014. Social interactions and well-being: The surprising power of weak ties. *Pers. Soc. Psychol. Bull.* 40 (7), 910–922.
- Steg, L., 2003. Factors influencing the acceptability and effectiveness of transport pricing. In: *Acceptability of Transport Pricing Strategies*. Emerald Group Publishing Limited, pp. 187–202.
- Steg, L., 2007. Sustainable transportation: A psychological perspective. *IATSS Research* 31 (2).
- Klimatutvalget (2023). Omstilling til lavutslippVeivalg for klimapolitikken mot 2050. NOU 23:5, Norwegian Ministry of climate and environment. Retrieved 11.01.2023 from <https://files.nettsteder.regjeringen.no/wpuploads01/sites/479/2023/10/Klimautvalget-2050.pdf>.
- Stopher, P., & Stanley, J. (2014). *Introduction to transport policy: a public policy view*. Edward elgar publishing.
- Straubinger, A., Rothfeld, R., Shamiyeh, M., Büchter, K.D., Kaiser, J., Plötner, K.O., 2020. An overview of current research and developments in urban air mobility—Setting the scene for UAM introduction. *J. Air Transp. Manag.* 87, 101852.
- Sun, X., Feng, S., Lu, J., 2016. Psychological factors influencing the public acceptability of congestion pricing in China. *Transport. Res. F: Traffic Psychol. Behav.* 41, 104–112.
- The jamovi project (2022). jamovi. (Version 2.3) [Computer Software]. Retrieved from <https://www.jamovi.org>.
- Ton, D., Zomer, L.B., Schneider, F., Hoogendoorn-Lanser, S., Duives, D., Cats, O., Hoogendoorn, S., 2020. Latent classes of daily mobility patterns: the relationship with attitudes towards modes. *Transportation* 47, 1843–1866.
- Tørnblad, S.H., Kallbekken, S., Korneliusen, K., Mideksa, T.K., 2014. Using mobility management to reduce private car use: Results from a natural field experiment in Norway. *Transp. Policy* 32, 9–15.
- Van Wee, B., De Jong, G., Nijland, H., 2011. Accelerating car scrappage: A review of research into the environmental impacts. *Transp. Rev.* 31 (5), 549–569.
- Van Wee, B., Annema, J.A., van Barneveld, S., 2023. Controversial policies: growing support after implementation. A Discussion Paper. *Transport Policy* 139, 79–86.
- Van Wee, B., 2009. *Transport policy: what it can and can't do?* Paper presented at the European Transport Conference, Noordwijkerhout 4–6. October 2009.
- Wang, Y., Geng, K., May, A.D., Zhou, H., 2022. The impact of traffic demand management policy mix on commuter travel choices. *Transp. Policy* 117, 74–87.
- Winkler, L., Pearce, D., Nelson, J., Babacan, O., 2023. The effect of sustainable mobility transition policies on cumulative urban transport emissions and energy demand. *Nat. Commun.* 14 (1), 2357.
- Xenias, D., Whitmarsh, L., 2013. Dimensions and determinants of expert and public attitudes to sustainable transport policies and technologies. *Transp. Res. A Policy Pract.* 48, 75–85.
- Zheng, Z., Liu, Z., Liu, C., Shiwakoti, N., 2014. Understanding public response to a congestion charge: A random-effects ordered logit approach. *Transp. Res. A Policy Pract.* 70, 117–134.
- Zhu, J., Xie, N., Cai, Z., Tang, W., Chen, X., 2023. A comprehensive review of shared mobility for sustainable transportation systems. *Int. J. Sustain. Transp.* 17 (5), 527–551.