

A Justice-Oriented Multilayer Analysis of Urban Travel Behavior in Tehran: Integrating Psychological, Social, and Structural Dimensions

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Abstract

Conventional models of travel demand analysis have largely relied on objective variables such as time, cost, and accessibility, and they fall short in explaining the complex linkages among the psychological, social, and structural factors underlying travel behavior. Adopting an interdisciplinary, justice-oriented approach, the present study undertakes a multilayered analysis of urban travel behavior in the metropolis of Tehran, seeking to elucidate the roles of subjective perceptions, social identity, and spatial inequalities in shaping transportation choices. The study was designed using an exploratory-interpretive method within a convergent (embedded) mixed-methods framework. In the quantitative phase, data were purposively collected via a questionnaire comprising 19 indicators from 40 citizens whose travel destinations lay within Tehran's traffic control zone, and were analyzed using exploratory factor analysis. In the qualitative phase, 18 in-depth semi-structured interviews were conducted with citizens from various districts of Tehran until theoretical saturation was achieved. The integration of the two phases occurred at the interpretive stage: the quantitative findings helped identify and classify the latent structures influencing travel behavior, while the qualitative data by revealing lived experience, perceptions of justice, cognitive load, travel-related anxiety, and the symbolic meanings of mobility modes contributed to deepening and validating the results. The advantage of this approach over prior studies lies in moving beyond one-dimensional analyses to offer a multilevel framework for understanding the interplay among spatial structure, social position, and travel behavior. The findings indicate that achieving transportation justice requires moving beyond formal equality of access to simultaneously address lived experience, regional disparities, and the socio-psychological dimensions of urban mobility. The proposed ecosystem-based and justice-oriented strategies are grounded in reducing cognitive load, enhancing psychological security in travel, and elevating the role of public transportation in accordance with the diverse circumstances and experiences of citizens.

Keywords: *Spatial inequality, Tehran, Transport justice, Urban travel behavior, Psychological factors.*

1. Introduction

Across the globe, metropolitan areas are increasingly adopting innovative policies to promote sustainable urban mobility. Successful experiences in cities such as London and Stockholm demonstrate that congestion pricing schemes can serve as effective policy instruments, reducing traffic volumes by up to 35% and air pollutant emissions by approximately 20% (Veitch & Rhodes, 2024). Understanding the complexity of travel behavior is therefore fundamental to the design of effective transportation policies. Likewise, travel demand management (TDM) strategies have shown considerable potential to reshape travel patterns, highlighting the growing importance of addressing the multidimensional interactions underlying travel behavior in metropolitan contexts. Against this backdrop, the international literature has increasingly emphasized the need to move beyond purely engineering-oriented approaches toward justice-oriented and psychologically informed perspectives. The multidimensional nature of transport justice, together with the decisive influence of psychological determinants, underscores the necessity of this conceptual shift. In their review of social justice in transportation, Carr and Hall (2024) argue that transport policies that neglect distributive justice and equitable accessibility disproportionately disadvantage socially vulnerable populations. Similarly, through a meta-analytic examination of the Theory of Planned Behavior (TPB), Lanzini and Khan (2017) demonstrate that latent individual-level factors, particularly attitudes and subjective norms, play a pivotal role in shaping travel mode choice (Lanzini & Khan, 2017). Integrating justice-oriented perspectives with psychological constructs is therefore essential for understanding the behavioral complexity of metropolitan travel and for moving beyond the limitations of conventional one-dimensional analytical frameworks.

Within the national context, and with particular reference to Tehran, the implementation of demand management measures including the Odd–Even Traffic Scheme and the Traffic Restricted Zone (TRZ) has reportedly reduced air pollution by approximately 18% (Tayrani Yousefabadi et al., 2019). Nevertheless, Tehran represents a metropolitan area characterized by highly differentiated spatial structures that distinguish it from many international cases. One of its most prominent characteristics is the deep structural disparity among different urban districts. Unofficial statistics indicate that public transport accounts for approximately 60% of trips in southern districts, compared with only 30% in northern districts. Such pronounced spatial heterogeneity suggests that generalized analyses that overlook the city's internal spatial diversity cannot adequately explain travel behavior in Tehran. Although previous Iranian studies have made valuable scholarly contributions, they have largely failed to capture this spatial complexity. For example, Mirbaha et al. (2014) estimated travelers' willingness to pay using a logit model, while Seyedebrihashi et al. (2018) investigated the impacts of integrated policy packages. However, these studies primarily emphasized technical and operational dimensions and were constrained by three major limitations. First, they reduced the diversity of Tehran's 22 municipal districts to a simplistic north–south dichotomy, thereby overlooking substantial intra-urban variation. Second, they paid insufficient attention to the dynamic interaction between psychological factors, such as decision-making anxiety, and structural constraints, despite more recent studies incorporating only limited aspects of these relationships through the Value–Belief–Norm (VBN) theory. Third, they exhibited a methodological gap by failing to integrate quantitative evidence on aggregate travel patterns with qualitative insights into individuals' lived experiences, leaving the perceived injustice experienced by residents of disadvantaged neighborhoods largely unexplored (Seyedebrihashi et al., 2018).

These theoretical and methodological shortcomings give rise to the central research question of this study: How do psychological, social, and structural factors interact to shape citizens' travel behavior in response to travel demand management policies within Tehran's Traffic Restricted Zone, and what are the implications of these interactions for the realization of transport justice?

To address this question, the findings are organized into four complementary analytical dimensions. The first examines the behavioral and socio-demographic characteristics influencing travel behavior. The second investigates the role of structural conditions and access to public transportation. The third explores the influence of psychological and normative factors on travel mode choice. Finally, the fourth integrates the quantitative and qualitative findings to develop a justice-oriented framework for explaining urban travel behavior. These dimensions do not constitute independent research questions; rather, they provide an analytical structure through which the central research question is examined and interpreted.

The principal contribution of this study lies in its multidimensional mixed-methods approach. To the best of the authors' knowledge, this research is among the first to integrate Exploratory Factor Analysis (EFA) with in-depth qualitative interviews to examine the interplay between objective and subjective determinants of travel behavior within a transport justice framework. By combining quantitative and qualitative evidence, the study provides a more comprehensive understanding of the complex interactions among spatial structures, social conditions, and psychological processes that collectively shape travel behavior in a metropolitan context.

2. Literature Review

2.1. Socio-Demographic Characteristics and Psychological Constructs Influencing Travel Behavior

Achieving justice in safe accessibility requires transport policies to extend beyond objective and physical dimensions and address the psychological and social security of travel environments. This objective is intrinsically linked to the concept of interactional and social justice in transportation. Psychological factors and subjective perceptions play a fundamental role in shaping travel behavior. In this regard, concerns related to traffic safety and personal security constitute critical determinants of travel mode choice. Mathematical modeling approaches, such as multinomial logit models, demonstrate that heightened anxiety associated with crossing congested streets and the lack of safe transport infrastructure both of which reflect deficiencies in interactional justice within urban space—substantially reduce individuals' willingness to use particular transport modes (Amiri Nezhad Ashoorabadi et al., 2025).

Interactional and gender justice within public transportation environments likewise reflect unequal experiences of safety as well as symbolic and physical violence. Existing evidence indicates that women and gender minorities are disproportionately exposed to harassment, discrimination, and violence in public transport systems, thereby significantly constraining their equitable access to urban spaces and everyday activities (Shakibaei & Vorobjovas-Pinta, 2022). Moreover, the adoption of gender-neutral transport planning approaches without accounting for caregiving responsibilities, income constraints, and women's previous negative travel experiences effectively reproduces gender inequalities. These findings underscore the necessity of developing transport policies that respond to actual gender-specific needs rather than assumed universal requirements in order to advance gender justice (Ari et al., 2022).

From a theoretical perspective, the Value–Belief–Norm (VBN) theory posits that individual values, beliefs, and justice-related norms guide transportation behavior. Cultural attitudes and symbolic values therefore shape travel preferences, behavioral responses to policy interventions, perceptions of spatial justice, and the acceptance of travel demand management policies (Zahabi et al., 2012; Seyedebrihshami et al., 2018). Travel decision-making is inherently dynamic and, according to attitude-based behavioral theories, operates through a cyclical process linking attitudes, preferences, behavioral intentions, and satisfaction. In this regard, De Vos et al. (2021) proposed a cyclical framework of travel mode choice by integrating attitudinal theories and modeling the reciprocal relationships among attitudes, intentions, behaviors, and travel satisfaction, demonstrating that these constructs are interconnected within a continuous feedback process.

From the perspective of economic psychology, cognitive burden represents a major constraint on travel decision-making. Elevated cognitive demands tend to encourage individuals to select low-effort alternatives, a phenomenon commonly referred to as the effort-minimization bias (Wieler et al., 2022). Within urban transportation systems, travel uncertainty substantially intensifies cognitive burden (Chakraborty et al., 2024). When the complexity of travel-related decisions exceeds individuals' cognitive capacity (Misuraca et al., 2024), decision fatigue alters travel mode preferences and behavioral patterns (Dominiak & Duersch, 2024). This theoretical mechanism provides a compelling explanation for travel behavior in urban environments characterized by heterogeneous levels of accessibility and service quality, where the coexistence of relatively adequate accessibility and poor service quality gradually generates mental exhaustion and persistent decision fatigue among travelers. Furthermore, individuals' perceptions of service quality and the availability of transportation alternatives significantly influence their travel motivation and behavioral intentions regarding mode choice (Schwanen & Mokhtarian, 2005).

Policy instruments and behavioral responses to pricing measures also reflect citizens' perceptions of whether regulatory frameworks conform to the principles of procedural justice, namely the fairness of decision-making processes and the extent of public participation. Empirical evidence suggests that structural inequalities persist even within democratic participatory processes. Women and marginalized groups consistently report substantially lower perceptions of procedural justice than men and consequently adopt more spatially constrained travel patterns, limiting their activity spaces to locations closer to home because of these structural barriers (Korpilo et al., 2022). Accordingly, coercive policy measures such as fare increases often impose disproportionate psychological and financial burdens on low-income groups, thereby exacerbating distributive injustice. By contrast, soft policy instruments, including information campaigns and awareness-raising initiatives, are more likely to induce long-term behavioral changes by transforming underlying attitudes.

Beyond attitudinal factors, personal identity and lifestyle also organize travel preferences and behavioral choices. Previous studies demonstrate that different lifestyles for example, physically active or family-oriented lifestyles are associated with distinct transportation preferences (De Vos et al., 2021). Moreover, the health and well-being outcomes associated with travel mode choice, including increased physical activity and enhanced psychological well-being among users of public and active transportation, indicate that travel experiences and the quality of interactions during travel constitute integral components of personal identity, well-being, and citizens' social rights

within broader frameworks of social and interactional justice. Supporting this argument, Ali and Macioszek (2023) found that individuals using public transport and non-motorized modes exhibit higher levels of physical activity and psychological well-being than private car users.

Finally, providing convenient and safe access to public transport stations enhances citizens' travel experiences while increasing their willingness to adopt sustainable modes of transportation. Consequently, land-use planning should function as an instrument for distributing opportunities within the framework of distributive justice, ensuring equitable access to public transport systems and promoting fairness in the allocation of mobility opportunities (Guo, 2023; Hakemian, 2024). Likewise, social network structures have been shown to exert a significant influence on mobility patterns, suggesting that travel choices are deeply embedded within social relationships and interactions (Puhhe et al., 2021). Empirical evidence from Tehran further substantiates these mechanisms. Investigating the causal relationship between the built environment and travel behavior across the Moniriyeh, Kouy-e Bimeh, and Golestan neighborhoods, Zabardast and Baghernajad (2020) demonstrated that, even after controlling for residential self-selection, built-environment characteristics including destination diversity and access to public transportation, both of which represent structural prerequisites for distributive justice exert a direct causal effect on promoting active travel behavior, particularly walking.

2.2. The Impacts of Unequal Access to Public Transportation on Travel Mode Choice: Spatial–Physical Structure and Economic Instruments

Urban transport systems should not merely be regarded as mechanisms for physical mobility; rather, they should function as structured platforms that ensure equitable, inclusive, and non-discriminatory access for all citizens. This principle constitutes the cornerstone of distributive justice within urban space (Moghadam et al., 2018; Mann & Abraham, 2024). The existing body of research on urban transportation suggests that conventional approaches to infrastructure evaluation have largely been grounded in utilitarian perspectives, which exhibit significant shortcomings in explaining the unequal distribution of social costs and benefits. In this regard, critiques of utilitarian approaches to infrastructure appraisal argue that prevailing evaluation frameworks pay insufficient attention to the unequal allocation of costs and benefits across different social groups (Amorim & João Abreu e Silva, 2024).

Among the most influential economic instruments employed in travel demand management is congestion pricing, which aims to alleviate traffic congestion while improving environmental quality. Evaluations of economic policy instruments based on Pigouvian taxation and area-based charging schemes demonstrate that congestion pricing can alter travel mode choice by internalizing the external costs of automobile use, thereby encouraging a modal shift toward public transportation (De Palma & Lindsey, 2011). Likewise, congestion charging policies implemented in metropolitan areas have been shown not only to reduce traffic volumes by as much as 35% but also to exert a direct influence on travel behavior while highlighting the importance of incorporating social justice considerations into transport policymaking (Veitch & Rhodes, 2024). Nevertheless, from the perspective of transport justice, substantial concerns remain regarding the distributive consequences of congestion pricing and public transport policies for socially disadvantaged populations. A systematic review of the transport justice literature indicates that, although such policies are effective in reducing congestion, their failure to comply with the principles of procedural justice throughout the policy-making process may impose disproportionate financial burdens on low-income groups while overlooking broader equity considerations (Singichetti et al., 2022). In this context, evaluations of congestion pricing policies provide valuable opportunities to assess health equity, examine policy impacts across different population subgroups, and promote intra-group dimensions of justice (Ghassabian et al., 2024).

Urban spatial structures and the distribution of public transportation infrastructure represent fundamental physical determinants of travel patterns, with the capacity either to reinforce or to reduce automobile dependency and motorized travel. The spatial, economic, and infrastructural configuration of the urban environment plays a pivotal role in shaping citizens' travel behavior, such that the equitable distribution of these resources becomes a primary determinant of accessibility and social well-being (Ghorbani et al., 2023). At the neighborhood level, the absence of safe pedestrian infrastructure and poor physical conditions of walking routes act as significant barriers to sustainable mobility. By directly influencing households' subjective perceptions, these deficiencies intensify feelings of psychological insecurity, illustrating the close interaction between the physical environment and the principles of interactional and safety justice (Amiri Nezhad Ashoorabadi et al., 2025).

Conversely, although Transit-Oriented Development (TOD) has emerged as a prominent strategy for improving structural accessibility, it is also associated with distributive justice challenges, including infrastructure-induced gentrification and the neglect of the essential needs of disadvantaged communities. Such unintended consequences may ultimately disrupt spatial equity to the detriment of lower-income populations (Yip et al., 2024). Similar inequalities are evident in the physical design of urban environments, which has frequently failed to accommodate women's mobility and safety requirements. As a result, existing planning approaches have often been unsuccessful

in advancing social justice because they neither adequately address women's daily travel patterns nor respond to the social exclusion they experience within urban transportation systems (Hamilton, 2010; Schlyter, 2010).

Within the field of urban economics, while classical models emphasize rational choice based on minimizing absolute costs such as housing rents and travel expenditures (Marwal & Silva, 2023), more recent perspectives highlight the importance of relative preferences and citizens' comparative perceptions of fairness. Empirical evidence indicates that spatial inequality in Tehran is structural, geographically embedded, and inherently multidimensional. Zarghamfard et al. (2023), for instance, reported that only 4.5% of Tehran's districts can be classified as highly advantaged, whereas more than 77% fall within the semi-advantaged category, with this disparity being particularly evident along the city's north-south divide. Similarly, Azmoodeh et al. (2022) demonstrated that the accessibility capability index for residents of central districts (0.628) is significantly higher than that of residents living in peripheral area (0.483).

These spatial and structural disparities provide an objective foundation for the emergence of relative deprivation perceptions. In other words, residents of semi-advantaged districts may experience stronger perceptions of distributive and interactional injustice despite having a reasonable level of physical accessibility, because they continuously compare their living conditions with those of more privileged neighborhoods. Such comparative perceptions of injustice cannot be adequately explained by traditional models that rely exclusively on absolute measures of accessibility and service provision.

For low-income populations, the perceived unfairness of traffic management policies and the economic burdens they impose reflects deficiencies in both procedural and distributive justice, potentially resulting in feelings of socioeconomic discrimination, spatial exclusion, and a substantial decline in perceived fairness regarding the distribution of urban resources (Singichetti et al., 2022; Amorim & João Abreu e Silva, 2024). Consistent with this perspective, and within the context of metropolitan Tehran, Zarei and Mamdouhi (2021) quantitatively evaluated equity in Tehran's public transportation system including the metro, bus, and Bus Rapid Transit (BRT) networks and demonstrated that the spatial distribution of transport services is highly inequitable relative to the needs of vulnerable populations. Based on Gini coefficient analyses, their findings revealed that the bus network performs more equitably than the metro system in terms of distributive justice because of its broader local coverage, whereas large areas of Tehran still lack adequate physical and geographical access to the metro network.

Taken together, these findings suggest that urban management strategies should adopt a comprehensive justice-oriented approach by integrating the principles of distributive, procedural, and interactional justice into both urban form and transport policy. Such an approach would facilitate the redesign of urban spatial structures and the reform of transport pricing mechanisms, thereby preventing the creation and reproduction of spatial and social inequalities that shape citizens' travel behavior.

2.3. The Role of Individual Norms in Travel Behavior: Subjective Perceptions, Psychological Security, and Multidimensional Justice

As discussed in the preceding section, analyses of spatial, economic, and infrastructural dimensions further underscore the importance of examining the decisive role of individual and socio-demographic characteristics in explaining travel behavior. A substantial body of research in urban transportation has shown that an exclusive emphasis on physical and environmental attributes has largely overlooked the social dimension of mobility and the spatial distribution of opportunities. Addressing these neglected dimensions is essential for understanding the diverse needs of different social groups and for promoting both distributive and gender justice in urban transportation systems (Moghadam et al., 2018).

In this regard, socio-demographic variables including age, gender, educational attainment, and income level have been consistently associated with travel behavior and individuals' access to urban opportunities. Empirical evidence indicates that car ownership, travel distance, age, gender, educational background, income, perceived safety, and weather conditions all exert statistically significant influences on travel mode choice (Akter & Alam, 2024). Together with cultural norms and value systems, these characteristics shape citizens' travel preferences. Consequently, regional, gender-based, and socioeconomic differences in travel behavior reflect the profound influence of these factors on how individuals interact with transportation systems and perceive interactional and social justice within the urban mobility environment (Kamkar, 2021; Mchi & Umoren, 2024).

Beyond socio-demographic characteristics, personality traits and psychological constructs also play a critical role in shaping travel patterns and determining the acceptance of justice-oriented transportation policies. Previous studies have demonstrated a close association between personality traits and sustainable travel behavior. In particular, personality stability has been found to correlate positively with private car use, whereas flexibility and adaptability are associated with a stronger preference for public transportation (Shahin et al., 2024). Likewise, car ownership and travel distance constitute key determinants for differentiating travel patterns across lifestyle groups. Different demographic profiles exhibit distinct transportation preferences; for example, active individuals typically younger,

physically active, and lower-income populations tend to favor public transportation, whereas family-oriented individuals, who are generally older, have higher incomes, and exhibit stronger preferences for private automobiles, display markedly different travel patterns (Senikidou et al., 2022). These lifestyle differences highlight the necessity of designing flexible transport policies and ensuring an equitable distribution of mobility options that accommodate the diverse preferences and needs of different population groups.

In this context, the existing literature provides substantial theoretical support for Bourdieu's framework, which conceptualizes consumption including travel mode choice as a mechanism for reproducing social class distinctions and maintaining social status and symbolic distinction (Atkinson, 2022; Bakti & Situmorang, 2024). Nevertheless, empirical evidence concerning the application of this perspective to travel behavior remains fragmented and, in some cases, contradictory. While several studies emphasize the decisive influence of income and social status on sustainable travel behavior (de Abreu e Silva & Lucchesi, 2022), others particularly those conducted in the context of metropolitan Tehran identify characteristics of the built environment and objective accessibility as the primary determinants of travel behavior, assigning a comparatively limited role to class identity in travel-related decision-making (Alizadeh & Sharifi, 2023). Consequently, although the theoretical concept of symbolic capital offers a valuable lens for interpreting travel preferences, there is currently limited empirical evidence demonstrating that resistance to behavioral change and persistent automobile dependence among affluent residents of Tehran are attributable solely to the reproduction of symbolic capital. Instead, these behavioral patterns may also be explained by other structural preferences and contextual factors.

At a deeper behavioral level, personality characteristics including adventurousness, preference for stability, conscientiousness, and individual risk aversion substantially influence responses to travel demand management policies. Individuals adapt their travel behavior when confronted with congestion charges, penalties, pricing policies, or increased travel complexity (Schwanen & Mokhtarian, 2005). From the perspective of procedural justice, these differences imply that standardized, one-size-fits-all policy interventions such as imposing substantial financial penalties without providing appropriate transportation alternatives for different personality profiles or income groups cannot be considered procedurally fair and are therefore likely to generate behavioral resistance among citizens. Accordingly, understanding travel behavior requires a multilayered analytical perspective that integrates socio-demographic characteristics, personality traits, and contextual conditions. Such an approach provides a stronger foundation for designing transportation policies that respond effectively to the actual needs of diverse social groups while enhancing their perceptions of justice within urban transportation systems (Shahin et al., 2024).

2.4. Theoretical Framework

A synthesis of the existing literature indicates that travel mode preferences and travel behavior are inherently dynamic, multidimensional, and nonlinear phenomena that emerge from the interaction between macro-level spatial and policy structures and micro-level social and psychological preferences. At the macro-policy level, Mamdouhi et al. (2022), drawing upon the welfare economics framework, demonstrated that the internalization of the external costs of transportation such as environmental pollution and traffic accidents requires the explicit incorporation of social costs into policy decision-making. This approach directly contributes to the realization of distributive justice through the equitable allocation of urban resources and transportation-related costs.

Conversely, a substantial body of behavioral research suggests that citizens' travel preferences cannot be explained solely by the instrumental rationality of cost–time trade-offs. Rather, travel decisions are significantly influenced by moderating variables such as income level, normative values, perceptions of spatial justice, and psychological responses to transport policies. These interacting mechanisms collectively shape the lived experience of interactional and social justice within urban mobility systems (Zahabi et al., 2012; Kamkar, 2021; Mchi & Umoren, 2024; Seyedebirishami et al., 2018).

Within the context of metropolitan Tehran, Mahpour and Saeidi Shahriyari (2022) further demonstrated that achieving transport justice requires eliminating spatial discrimination while recognizing the structural and socioeconomic disparities among urban districts. Their empirical findings indicate that restrictive and punitive measures such as increasing congestion charges or access fees without simultaneously providing viable transportation alternatives place disproportionate financial burdens on low-income and peripheral populations. Such policies represent clear violations of both procedural justice, because stakeholders' constraints are insufficiently considered during policy formulation, and distributive justice, because policy costs are allocated inequitably across social groups. In contrast, participatory, educational, and incentive-based policy measures have been shown to generate greater long-term effectiveness and higher levels of public acceptance.

To operationalize these theoretical concepts and establish consistency with the study's conceptual framework, the travel behavior indicators employed in this research were reorganized into three overarching dimensions of justice:

Distributive Justice: This dimension comprises economic indicators, including affordability and the correspondence between transportation costs and service quality (Zahabi et al., 2012; Mchi & Umoren, 2024;

Mirbaha et al., 2014), together with spatial and physical indicators such as accessibility to transport networks and route flexibility (Schwanen & Mokhtarian, 2005; Kamkar, 2021; Jeong et al., 2022). Collectively, these indicators represent the structural foundations of equitable accessibility.

Procedural Justice: This dimension encompasses policy-related and institutional indicators, including the public acceptance of traffic management policies, the perceived effectiveness of pricing mechanisms, and the fairness of transportation decision-making processes (Schuitema et al., 2011; Ecola & Light, 2009).

Interactional–Social Justice: This dimension incorporates psychological, perceptual, and gender-related indicators, including perceived safety within urban spaces, perceptions of fairness, and behavioral preferences associated with different lifestyles and social groups (Kamal et al., 2019).

A comprehensive review of the literature reveals that, despite significant advances in transportation research, most previous studies have remained confined to one-dimensional perspectives, mathematical–economic modeling approaches, or purely technical analyses. Consequently, they have generally failed to integrate individual-level determinants including psychological and perceptual factors with external constraints such as spatial structures and the multidimensional principles of urban justice. Within the context of metropolitan Tehran, existing research has similarly oversimplified the city's spatial diversity by relying on binary classifications, most notably the north–south divide, thereby overlooking substantial intra-urban heterogeneity. Furthermore, a considerable methodological gap persists regarding the application of mixed-methods approaches capable of simultaneously examining objective transportation indicators alongside citizens' subjective perceptions of injustice across different urban contexts.

To address these theoretical, methodological, and practical gaps, the present study adopts a multilayered, justice-oriented analytical framework that integrates Exploratory Factor Analysis (EFA) with in-depth qualitative interviews. Through this mixed-methods design, the study seeks to develop a comprehensive framework for explaining the interactive relationships among urban spatial structure, citizens' perceptions of distributive, procedural, and interactional justice, and travel behavior in metropolitan Tehran. Based on the theoretical synthesis and the process of indicator integration, the conceptual framework of the study is presented in Table 1, which illustrates the relationships among the principal constructs and serves as the analytical foundation for the interpretation of the empirical findings.

The proposed framework synthesizes theoretical perspectives from transportation planning, urban economics, environmental psychology, and spatial justice studies, classifying the principal determinants of travel behavior into four interrelated components: (1) individual and socio-demographic characteristics, (2) spatial–economic and infrastructural conditions, (3) subjective perceptions and evaluative judgments, and (4) psychological and behavioral factors.

Within this framework, individual and socio-demographic characteristics, including age, gender, and educational attainment, constitute the fundamental determinants of travel needs and mobility patterns. Spatial–economic and infrastructural conditions represent the objective characteristics of the urban environment, whereby income level, access to public transportation, and the physical quality of travel routes function as structural opportunities or constraints influencing travel choices. At a deeper analytical level, subjective perceptions and evaluative judgments reflect citizens' interactions with the transportation system, such that perceptions of justice, experiences of discrimination, and evaluations of traffic management policies directly influence the acceptance or rejection of transportation policies and services. Finally, psychological and behavioral factors—including automobile-oriented values, perceived safety, and social influence capture the motivational and internalization processes that ultimately shape travel mode choice.

Taken together, this multilayered conceptual framework enables the simultaneous examination of both the objective and subjective dimensions of travel behavior. The relationships among these four components and their corresponding operational indicators are illustrated in Figure 1, which demonstrates the consistency between the theoretical foundations of the study and its operational analytical framework.

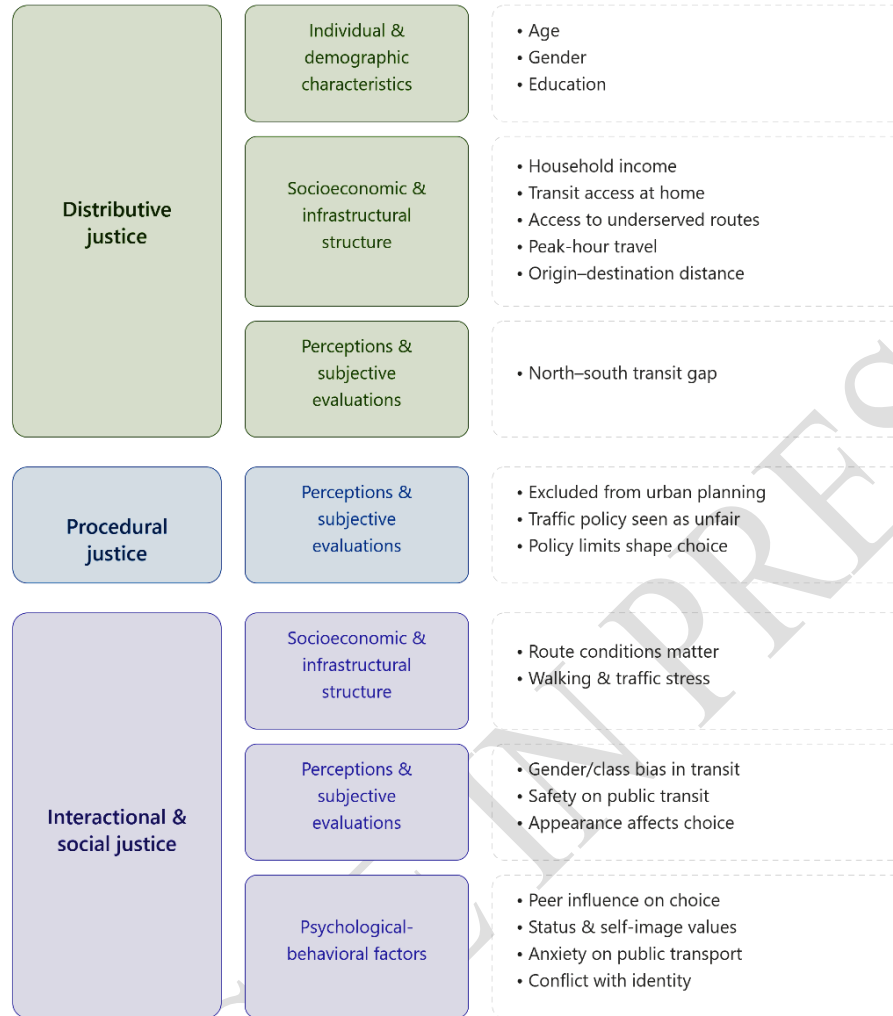


Figure 1. The Theoretical Framework of the Study

3. Methodology

This study employed a mixed-methods descriptive–analytical design based on the Honeycomb Model to examine the multilayered nature of urban travel behavior in Tehran through a justice-oriented perspective. This methodological approach was adopted to capitalize on the complementary strengths of quantitative and qualitative data. While the quantitative component was used to identify the underlying structural relationships among the study variables, the qualitative component provided an in-depth understanding of citizens' lived experiences and subjective perceptions, thereby enriching the analysis of travel behavior within the broader context of spatial justice and its psychological, social, and structural dimensions.

The field survey was conducted within Tehran's Congestion Charging Zone (CCZ) during May and June 2025. Participants were purposively recruited from different municipal districts of Tehran to ensure diversity in travel experiences, socioeconomic backgrounds, and residential contexts, thereby capturing the heterogeneity of urban travel behavior across the city.

The study population comprised citizens whose travel destination was located within the Tehran Congestion Charging Zone. Different sampling strategies were employed for the quantitative and qualitative phases. In the quantitative phase, 40 questionnaires were collected as an exploratory pilot sample to identify preliminary latent structures, refine the measurement items, and generate initial patterns among the study variables. This sampling strategy is consistent with methodological recommendations for exploratory and pilot studies, where relatively small samples are considered appropriate for the preliminary evaluation of measurement instruments. Previous methodological studies have suggested that a minimum of approximately 30 respondents is adequate for assessing questionnaire reliability, while Hertzog (2008) recommends sample sizes ranging from 10 to 40 participants for

various pilot-study objectives (Hertzog, 2008; Bujang et al., 2024). Accordingly, the sample of 40 respondents was considered sufficient for the exploratory factor analysis conducted in conjunction with the qualitative findings.

Subsequently, purposive sampling was employed to recruit participants whose travel destination was the Tehran Congestion Charging Zone. The analytical framework of this study conceptualizes travel behavior across three interconnected dimensions:

- Structural (objective) dimension: including accessibility to public transportation (e.g., station density), travel costs, and the physical characteristics of travel routes.
- Psychological (subjective) dimension: including cognitive load, travel anxiety, and perceived safety.
- Social (identity-related) dimension: including symbolic capital, group norms, and perceptions of justice.

To operationalize these dimensions, a researcher-developed questionnaire consisting of 19 final indicators measured on a five-point Likert scale was designed. The psychological and social constructs were derived from a systematic review of the literature and established theoretical frameworks. The content validity of the instrument was evaluated and confirmed by experts in transportation planning and spatial justice. Internal consistency was assessed using Cronbach's alpha, with all constructs achieving acceptable reliability ($\alpha \geq 0.70$).

The quantitative data were analyzed using Exploratory Factor Analysis (EFA) to identify, reduce, and classify the latent variables influencing travel mode choice. Given the exploratory nature of the research and its emphasis on understanding the complex interactions among psychological, social, and structural determinants of travel behavior, purposive sampling was considered the most appropriate sampling strategy. Sample size determination was guided by theoretical saturation in the qualitative phase and by the minimum methodological requirements for exploratory factor analysis in the quantitative phase.

From a temporal perspective, the study adopts a cross-sectional design, while in terms of research purpose it is applied research. Philosophically, the study progresses from ontological and epistemological considerations toward methodological implementation and policy implications, reflecting the interdisciplinary nature of justice-oriented transportation research.

Within this study, transport justice is conceptualized as a multidimensional construct that extends beyond the statistical equality of accessibility to encompass the equitable distribution of travel experiences and hidden mobility costs. Operationally, transport justice is evaluated through three complementary dimensions:

- Economic (Distributive) Justice, referring to the proportionality between travel costs (both monetary and temporal) and household affordability, together with equitable access to high-quality transportation infrastructure. This dimension is measured using objective indicators, including travel cost relative to household income, public transport station density, and pedestrian infrastructure quality.
- Procedural Justice, referring to the transparency of transportation decision-making processes and citizens' opportunities to participate in transport policymaking. This dimension is operationalized through indicators such as perceived ability to influence major transportation decisions and perceived transparency of information provided to transport users.
- Social (Interactional) Justice, referring to the recognition of the needs of diverse social groups particularly women and low-income populations and the reduction of structural discrimination within urban space. This dimension is primarily examined through qualitative analysis of participants' lived experiences of discrimination, perceived psychological safety, and perceptions of class-based stigma associated with the use of public transportation.

In this study, the logic for determining sample size differed between the quantitative and qualitative components. The qualitative data serve a complementary and explanatory function, capable of partially offsetting the limited sample size of the quantitative component. Accordingly, in the qualitative component, the number of participants was determined according to the principle of theoretical saturation—that is, the interview process continued until new data no longer contributed to the expansion of categories and themes. In the quantitative component, however, sample size was determined not on the basis of theoretical saturation but in light of the exploratory nature of the research, constraints on field access, and the study's objective of identifying preliminary structures and latent relationships among variables. On this basis, 40 questionnaires were collected as an initial sample for conducting exploratory factor analysis. While this sample size is evidently insufficient for broad statistical generalization, as a preliminary exploratory analysis combined with rich qualitative data, it enables the identification of initial patterns and the development of a preliminary conceptual framework. Thus, reference to theoretical saturation pertains solely to the qualitative component of the study, whereas the quantitative component was designed according to methodological considerations specific to exploratory mixed-methods studies and practical feasibility constraints.

- Quantitative component: A total of 40 questionnaires were identified as the initial sample. Although this sample size is insufficient for broad statistical generalization, it holds adequate validity in exploratory

mixed-methods research aimed at "identifying the latent structure" of variables, particularly when enriched with qualitative data.

- Qualitative component: The process of in-depth semi-structured interviews continued through 18 interviews. Thereafter, the recurrence of concepts and the absence of new emergent data indicated that theoretical saturation had been reached and the cognitive scope of the research had been completed.

Following data collection, Exploratory Factor Analysis (EFA) was employed in the quantitative component to identify, reduce, and classify the variables influencing travel mode choice. After data collection, preliminary tests were conducted to assess compliance with the assumptions of factor analysis. Skewness and kurtosis indices were calculated, and Bartlett's test of sphericity along with the KMO index (0.5) were used to evaluate sampling adequacy. In the first step, principal component analysis was performed in SPSS version 26 without rotation to determine the number of potential factors. Based on the eigenvalue criterion (Eigenvalue ≥ 1) and confirmation of the second breakpoint in the scree plot, six factors were identified as the final structure, jointly explaining 67.73% of the total variance.

In determining the type of rotation, an oblique rotation method was first applied and the factor correlation matrix was examined. Given that all absolute correlation coefficients between factors were below 0.32, the assumption of significant correlation between factors was rejected; accordingly, an orthogonal rotation method was selected and applied. Following rotation, factor loadings were analyzed, with an acceptance threshold of 0.4 applied to factor loadings. To facilitate interpretation and enhance spatial comparability, all factor scores were calculated using the regression method in SPSS and subsequently transformed to a zero-to-one scale using the min-max normalization formula. The factor scores were then used for the interpretation and comparison of results.

To deepen and interpret the quantitative findings, thematic analysis was employed. Interview data were analyzed using MAXQDA software, based on Braun and Clarke's six-phase algorithm (open, axial, and selective coding). To enhance the credibility of the findings, results were reviewed with participants, and two independent researchers assessed and confirmed the coding process and thematic structure to ensure internal consistency and analytical validity. In the final stage, quantitative and qualitative data were systematically integrated using a nested (honeycomb) model. On this basis, an integrated model of justice-oriented travel behavior was developed, with its main categories derived from the overlap and convergence of the quantitative and qualitative data. Throughout the research process, Lincoln and Guba's four criteria (credibility, transferability, dependability, and confirmability) were applied to ensure the quality and validity of the findings. The characteristics of the statistical population are presented in Table 1.

Table 1. Characteristics of the Statistical Population

Characteristics	Quantitative Component	Qualitative Component
Total number of participants	individuals ۴۰	individuals ۱۸
Primary criterion for area selection	Level of socioeconomic advantage of the area of residence	Level of socioeconomic advantage of the area of residence and lived urban experience
Gender		
Men	(۵۷/۵٪) individuals ۲۳	(۳۸/۹٪) individuals ۷
Women	(۴۲/۵٪) individuals ۱۷	(۶۱/۱٪) individuals ۱۱
Mean age	34.5 years	years ۳۸/۲
Educational level		
Diploma or below	(۲۰/۰٪) individuals ۸	(۱۱/۱٪) individuals ۲
Bachelor's degree	(۴۵/۰٪) individuals ۱۸	(۳۳/۳٪) individuals ۶
Master's degree	(۲۵/۰٪) individuals ۱۰	(۳۸/۹٪) individuals ۷
Doctorate	(۱۰/۰٪) individuals ۴	(۱۶/۷٪) individuals ۳

The table above presents the demographic characteristics of the participants and the distribution of the sample based on the level of socioeconomic advantage of the residential area. Participants were selected from various areas of Tehran to preserve diversity in perspectives and experiences related to travel behavior within the research sample.

In the qualitative component, sampling was conducted purposively, and alongside attention to the individual characteristics of participants, efforts were made to maintain regional diversity as well. Accordingly, 6 individuals were selected from each of the three levels of socioeconomic advantage, resulting in a total of 18 in-depth interviews. This equal distribution in the qualitative component ensured that the lived experiences of participants

from different areas of Tehran were reflected in a balanced manner in the qualitative analysis. In terms of gender, in the quantitative component, 23 participants (57.5%) were male and 17 participants (42.5%) were female. In the qualitative component, the gender composition differed, with 11 participants (61.1%) being female and 7 participants (38.9%) being male. The increased proportion of women in the qualitative component was intended to capture deeper narratives of gendered experiences in relation to space, urban travel, and the sense of safety.

The mean age of participants was 34.5 years in the quantitative component and 38.2 years in the qualitative component. Regarding educational level, in the quantitative component, the highest frequency corresponded to individuals holding a bachelor's degree, with 18 participants (45.0%). In the qualitative component, the proportion of individuals with graduate education was higher, with 7 participants (38.9%) holding a master's degree and 3 participants (16.7%) holding a doctorate. This educational composition in the qualitative component enhanced participants' capacity to articulate more precisely their experiences and concepts related to spatial justice, travel experience, and perceptions of urban inequalities. Overall, the sample distribution in this study was designed not only to cover the demographic characteristics of participants but also to represent the geographic diversity of participants' places of residence in both the quantitative and qualitative components. This enhances the methodological rigor of the study and enables comparative analysis of participants' experiences and perceptions across diverse urban contexts.

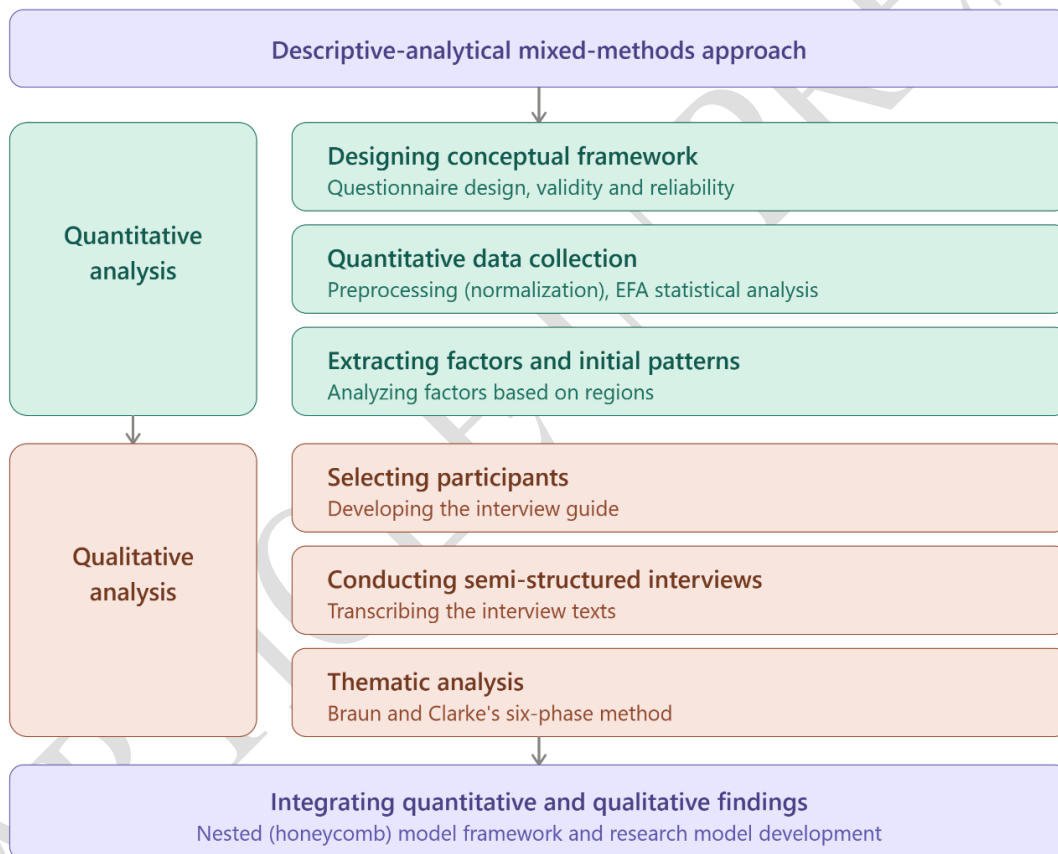


Figure 2. Research Methodology Process

4. Findings

This study, drawing on a mixed-methods approach, examines the travel preferences of Tehran residents based on the degree of socioeconomic disparity. To address the study's methodological concerns and ensure full alignment with the theoretical framework, the analysis of findings is organized around the tripartite structure of justice (distributive justice, procedural justice, and interactional–social justice). Within this framework, the quantitative data provide the structural and conceptual foundation, while the qualitative data, by introducing semantic layers grounded in experiential narratives, contribute depth and richness to the analysis. Accordingly, the first section presents the results of the exploratory factor analysis conducted to identify and classify the factors influencing travel behavior through the lens of multidimensional justice; this is followed by an examination of citizens' perceptions of

these same dimensions through thematic analysis of the in-depth interviews, so that a comprehensive and coherent picture of travel behavior patterns in Tehran can be drawn by integrating the two levels of analysis.

This study, drawing on a mixed-methods approach, examines the travel preferences of Tehran residents based on the level-of-advantage component. To address the study's methodological concerns and ensure full alignment with the theoretical framework, the analysis of findings is organized around the tripartite structure of justice (distributive justice, procedural justice, and interactional–social justice). Within this framework, the quantitative data provide the structural and conceptual foundation, while the qualitative data, by introducing semantic layers grounded in experiential narratives, contribute depth and richness to the analysis. In what follows, the quantitative analysis process (exploratory factor analysis) and the qualitative analysis process (thematic analysis) are first briefly introduced, and the findings from both components are then reported according to the four key research axes, so that the answer to each axis is clearly identified.

4.1. Quantitative analysis process: extraction and classification of factors

The exploratory factor analysis in this study was designed and conducted with the aim of assessing the relative influence of key components on travel behavior within the traffic control zone and performing a comparative analysis across areas with differing levels of socioeconomic advantage. To ensure theoretical correspondence, the analysis process began with the extraction of operational indicators from the relevant literature and their organization into a five-layer hierarchical conceptual framework; all of these layers and the 21 operational indicators are directly linked to the three dimensions of justice (distributive, procedural, and interactional–social):

- Individual and demographic characteristics (related to distributive justice): including age, gender, and education, which are linked to perceptions of inequality in the distribution of opportunities.
- Spatio-economic and infrastructural structure (related to distributive and interactional justice): including income, access to public transport, access to diverse options, peak-hour travel, and time distance, which form the foundation of spatial distributive justice, alongside the physical conditions of the route, which is tied to interactional justice.
- Perceptions and subjective evaluations (related to all three dimensions of justice): including north–south inequality (distributive justice), lack of participation in decision-making and perceived unfairness of policies (procedural justice), and experiences of gender/class discrimination, social security, and route monitoring (interactional justice).
- Psychological–behavioral factors (related to interactional and social justice): including the influence of peers, self-centered values, anxiety, and a sense of conflict with lifestyle, which represent the psychological consequences of interactional injustice within the transport system.
- Travel behavior and final choice: the final behavioral outcome of decision-making in the face of these justice-oriented layers.

Ultimately, the extracted indicators were entered into the factor analysis model. The exploratory factor analysis was conducted using SPSS software on 19 final indicators. In the first step, the assumption of normal data distribution was assessed through skewness and kurtosis coefficients. For three indicators — household income, travel time distance, and the importance of route monitoring which showed significant deviation from normality, a data transformation technique was applied. In addition, discrete and categorical indicators such as gender and area of residence were excluded from the factor analysis process, owing to their incompatibility with the assumptions of linear correlation, and were set aside for supplementary analyses.

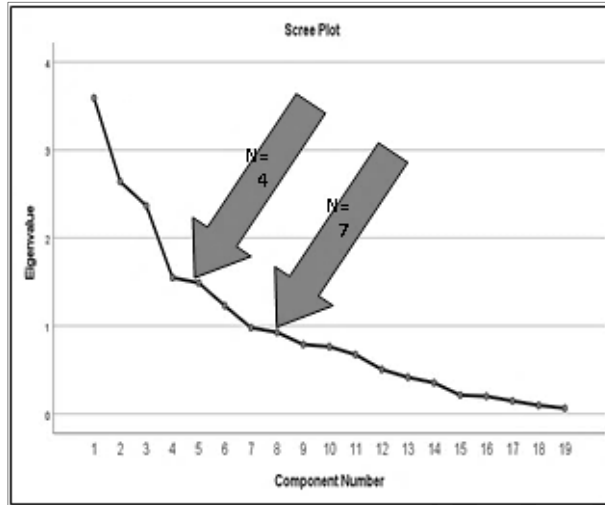
Table 2. Bartlett's test and KMO value

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.500
Bartlett's Test of Sphericity	Approx. Chi-Square	276.535
	df	171
	Sig.	<.001

To ensure the proportionality of the data and the study's indicators, the numerical value of KMO and Bartlett's test are of key importance; Bartlett's test must reach a 95% confidence level for the data to be considered suitable for factor analysis (Zebardast, 2017). To assess sampling adequacy, Bartlett's test of sphericity and the overall KMO index (0.5) were calculated. The significance of Bartlett's test and the placement of the KMO value at an acceptable threshold confirmed the suitability of the data for proceeding with the analysis. To determine the number of factors, principal component analysis was performed without rotation. Based on Kaiser's eigenvalue criterion (Eigenvalue $\geq$

1) and the explanation of 67.73% of the total variance, the six-factor structure was selected as the optimal model. This selection was further confirmed by examining the scree plot and identifying the second breakpoint, which ruled out the three-factor model, as it explained less than 60% of the variance.

Figure 3. Scree plot for determining the number of factors



By combining the findings of the two aforementioned criteria and confirming the six-factor structure, a substantial share of the variance was explained. Following the application of orthogonal (Varimax) rotation adopted because the correlation between factors under direct oblimin (oblique) rotation was below 0.32 indicators were precisely allocated to their respective factors. The process of naming and interpreting the factors was carried out with the aim of establishing full correspondence with the dimensions of distributive, procedural, and interactional justice:

- Factor one; the interactional–social and perceptual dimension of the travel experience (interactional justice): This factor showed the highest factor loadings on the indicators of the importance of physical route conditions (0.89), peak-hour travel (0.825), and feelings of stress and anxiety in public transport (0.631). The combination of these indicators indicates that the quality of an individual's physical and psychological interactions with the transport system forms the foundation of interactional justice — where deficiencies in physical infrastructure translate directly into psychological harm and passenger stress.
- Factor two; normative and policy dimensions of travel preferences (procedural justice): This factor is defined primarily by the indicator of peer influence (0.763), along with traffic policy restrictions and social security. This dimension shows that citizens' travel decisions are shaped by structural regulations and social contexts that is, by the procedures governing urban management.
- Factor three; spatial inequalities and distributive injustice in urban transport (distributive justice): This factor showed a strong negative loading for the indicator of north–south transport inequality (–0.736), along with other indicators related to gender-, class-, and appearance-based discrimination. These negative loadings confirm citizens' deep perception of the unjust distribution of transport opportunities and services across the geography of the Tehran metropolis.
- Factor four; participatory governance and policy legitimacy (procedural justice): In this factor, the indicators of a sense of participation in decision-making and the perceived unfairness of traffic policies carry high factor loadings. This factor directly reflects "procedural justice" and shows that citizens accept traffic policies only when they have had a role in shaping them.
- Factor five; cultural capital and attitudes toward structural restrictions (interactional and procedural justice): This factor is characterized by a negative loading for education (–0.601) and positive loadings for self-centered values. This reflects a tension between individual lifestyle (interactional justice) and the acceptance of traffic restrictions imposed by governing authorities (procedural justice).
- Factor six; lived experience of discrimination and social exclusion (interactional justice): This factor emerged as a single-variable factor, defined by the indicator of experiencing gender- and class-based discrimination in public transport (0.588). The independence of this factor underscores the vital and non-reducible importance of interactional–social justice in the everyday travel experience of women and vulnerable groups.

Table 3. Extracted factors for the analysis of urban travel behavior and their percentage of variance explained

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.592	18.907	18.907	3.592	18.907	18.907
2	2.641	13.901	32.808	2.641	13.901	32.808
3	2.366	12.453	45.260	2.366	12.453	45.260
4	1.549	8.155	53.416	1.549	8.155	53.416
5	1.490	7.844	61.259	1.490	7.844	61.259
6	1.230	6.472	67.731	1.230	6.472	67.731
7	.980	5.159	72.890			
8	.927	4.880	77.770			
9	.789	4.153	81.923			
10	.764	4.022	85.945			
11	.674	3.547	89.492			
12	.505	2.659	92.151			
13	.416	2.189	94.340			
14	.354	1.862	96.202			
15	.214	1.124	97.326			
16	.200	1.052	98.378			
17	.147	.773	99.151			
18	.097	.511	99.663			
19	.064	.337	100.000			
Extraction Method: Principal Component Analysis.						

In the final stage, to select the rotation method, the analysis was first conducted using Direct Oblimin. Given that the absolute correlation coefficients between factors were below 0.32 and the assumption of significant correlation was rejected, orthogonal rotation using Varimax was applied. This analysis resulted in the final extraction of six factors and the precise allocation of 19 indicators to the component structure of travel behavior.

Table 4. Extracted factors, factor loadings, and their labeling

Factor	Indicator	Factor loading
Individual and perceptual characteristics in the travel experience	Importance of physical route conditions	0.89
	Peak-hour travel	0.825
	Importance of route monitoring and traffic stress	0.577
	Feelings of stress and discomfort in public transport	0.631
	Self-centeredness	0.472
	Appearance, accent, and clothing	0.483
	Age	-0.452
	Education	0.403
	Influence of peers	0.763
	Traffic policy restrictions	0.538
Social and policy dimensions in travel behavior	Social security	0.414
	Sense of participation in decision-making	0.465
	North-south transport inequality	-0.736
	Perceived unfairness of policies	-0.481
Inequality and social injustice in urban transport	Experience of gender and class discrimination	-0.45
	Appearance, accent, and clothing	-0.405
	Social security	-0.403
	Age	0.483
Urban governance and policy-making	Influence of peers	0.763
	Social security	0.447
	Traffic policy restrictions	0.538
	Sense of participation in decision-making	0.531
Cultural capital and attitude toward transport policies	Education	-0.601
	Self-centeredness	0.414
	Traffic policy restrictions	0.538

	Sense of participation in decision-making	0.511
Lived experience of discrimination in public transport	Experience of gender and class discrimination	0.588

To measure the factor scores, the regression method in SPSS was used, which offers sufficient efficiency given the nature of the analysis and the fact that it does not require the assumption of complete independence among factors (a requirement of the Anderson–Rubin method). To examine spatial differences based on the level of advantage of the areas, the scores of the six factors were converted to a zero-to-one scale using the min–max normalization formula, enabling comparative analysis across the three justice contexts.

$$I_i^n = \frac{X_i - X_{Min}}{X_{Max} - X_{Min}}$$

where I_i is the normalized indicator and X_i is the raw value of the indicator in area i . The scores of the six factors influencing travel mode choice were compared based on the socioeconomic differences among respondents. Classifying these scores into five ranges and analyzing their spatial distribution provides a precise understanding of the behavioral and structural differences among various areas of Tehran.

The table below shows the spatial distribution of the scores of these six factors across three levels of advantage (advantaged, semi-advantaged, and disadvantaged). These scores depict the intensity of citizens' perceptions of the indicators of distributive, procedural, and interactional justice across different zones of the Tehran metropolis. The normalized values, ranging from zero to one, represent the intensity and weight of each factor in shaping the travel behavior of residents in different areas of Tehran.

Table 5. Comparative analysis of the scores of factors influencing travel behavior based on the socioeconomic characteristics of respondents

Interpretation and spatial distinctions	Lower socioeconomic group	Middle socioeconomic group	Higher socioeconomic group	Factor influencing travel behavior
Higher socioeconomic group: high flexibility and a sense of control resulting from access to diverse options. Lower socioeconomic group: the persistently high score stems from the intensity of stress and the poor quality of infrastructure (a forced negative experience).	0.4981	0.4851	0.5313	Individual and perceptual characteristics in the travel experience
Lower socioeconomic group: strong dependence on informal social networks and high sensitivity to regulatory restrictions. Higher socioeconomic group: a diminished role for social dimensions, with greater reliance on individual choices and personal resources.	0.3997	0.3962	0.3884	Social and policy dimensions in travel behavior
Middle socioeconomic group: the peak sense of injustice, arising from an intermediary position and constant comparison with advantaged areas (class- and appearance-based discrimination). Lower socioeconomic group: normalization of inequality and reduced critical awareness due to the absence of a basis for comparison.	0.4191	0.9556	0.4106	Inequalities and social injustice in urban transport

Interpretation and spatial distinctions	Lower socioeconomic group	Middle socioeconomic group	Higher socioeconomic group	Factor influencing travel behavior
Middle socioeconomic group: high demand for participation in the absence of channels of influence, alongside a sense of procedural injustice. Higher socioeconomic group: a more positive perception of procedural justice and acceptance of restrictions as managed rules.	0.5525	0.6079	0.5233	Governance and participation in transport policy
Lower socioeconomic group: a strong inclination toward car-centeredness as a symbolic value, and resistance to restrictive policies. Higher socioeconomic group: high cultural capital has led to greater flexibility and use of alternative options.	0.7221	0.4508	0.7017	Cultural capital and individual attitudes toward policies
Higher socioeconomic group: a tangible experience of gender- and class-based discrimination that transcends class boundaries. Lower socioeconomic group: the combination of economic and social constraints has led to the reproduction of inequalities and a sense of insecurity.	0.4436	0.337	0.5045	Lived experience of discrimination in public transport

4.2. Qualitative analysis process: thematic analysis of in-depth interviews

The thematic analysis of the data obtained from the in-depth interviews revealed deeper layers of the lived experience of Tehran residents in relation to the three dimensions of justice. These findings showed that travel behavior is a reflection of the complex interplay between psyche, geography, and urban policy. The qualitative narratives were first extracted in the form of five main themes. Subsequently, in order to address the study's central research question, these themes were integrated and interpreted alongside the related quantitative findings within the study's four analytical axes.

Axis one: comparative analysis of travel preferences across different levels of advantage

- Factor five; cultural capital and attitudes toward structural restrictions (interactional and procedural justice): This factor is characterized by a negative loading for education (-0.601) and positive loadings for self-centered values. This reflects a tension between individual lifestyle (interactional justice) and the acceptance of traffic restrictions imposed by governing authorities (procedural justice).
- Social identity and the role of self-image (interactional and social justice): The choice of travel mode serves as a tool for face management and the maintenance of social standing. Fear of class-based stigma in public transport and the preference for car-centeredness as a symbol of distinction reflect the social dimensions of interactional justice in travel.

Axis two: examining the consequences of unequal access to public transport

- Factor three; spatial inequalities and distributive injustice in urban transport (distributive justice): This factor showed a strong negative loading for the indicator of north–south transport inequality (-0.736), along with other indicators related to gender-, class-, and appearance-based discrimination. These negative loadings confirm citizens' deep perception of the unjust distribution of transport opportunities and services across the geography of the Tehran metropolis.
- Factor six; lived experience of discrimination and social exclusion (interactional justice): This factor emerged as a single-variable factor, defined by the indicator of experiencing gender- and class-based discrimination in public transport (0.588). The independence of this factor underscores the vital and

non-reducible importance of interactional–social justice in the everyday travel experience of women and vulnerable groups.

- Spatial and experienced inequalities (distributive justice): The narratives showed that the unbalanced distribution of the metro and bus fleet and local accessibility has turned traffic policies (such as the traffic control zone scheme) into a punitive mechanism for residents of less-advantaged areas. This constitutes a clear instance of distributive injustice at the city level.

Axis three: explaining the role of individual norms in transport-related behaviors

- Factor one; the interactional–social and perceptual dimension of the travel experience (interactional justice): This factor showed the highest factor loadings on the indicators of the importance of physical route conditions (0.89), peak-hour travel (0.825), and feelings of stress and anxiety in public transport (0.631). The combination of these indicators indicates that the quality of an individual's physical and psychological interactions with the transport system forms the foundation of interactional justice where deficiencies in physical infrastructure translate directly into psychological harm and passenger stress.
- Psychological perception and mental engagement (interactional and social justice): The exhausting process of evaluating inefficient transport options leads to decision fatigue and pre-travel anxiety. This psychological consequence stems from the system's failure to provide a dignified and smooth travel experience (interactional justice) for citizens.
- Social security and environmental sensitivity (interactional and social justice): Security for passengers particularly women means, beyond the mere absence of physical threat, freedom from verbal and visual harassment. This underscores the necessity of improving indicators of interactional justice in public spaces.

Axis four: designing a justice-oriented framework based on the mixed-methods findings

- Factor two; normative and policy dimensions of travel preferences (procedural justice): This factor is defined primarily by the indicator of peer influence (0.763), along with traffic policy restrictions and social security. This dimension shows that citizens' travel decisions are shaped by structural regulations and social contexts that is, by the procedures governing urban management.
- Factor four; participatory governance and policy legitimacy (procedural justice): In this factor, the indicators of a sense of participation in decision-making and the perceived unfairness of traffic policies carry high factor loadings. This factor directly reflects "procedural justice" and shows that citizens accept traffic policies only when they have had a role in shaping them.
- Sensitivity to policies and procedural justice: The qualitative narratives showed that the lack of avenues for citizen participation in the design of traffic policies has led to distrust of urban institutions and evasion of regulations a phenomenon rooted directly in procedural injustice.

To establish a systematic link between the quantitative and qualitative components based on the justice-oriented framework, Table 6 presents an integrated, comparative analysis of travel preferences. This analysis shows that travel preferences are the product of a dynamic interaction among structural constraints, psychological perceptions, and cultural capital.

Table 6. Integrated and comparative analysis of the factors influencing travel preferences across different areas of Tehran

Analytical factor	Foundational and theoretical components	Comparative analysis of areas and the underlying mechanism
Individual perceptual characteristics; psychological perception and mental engagement	Decision fatigue, cognitive load, perceived monitoring, structural coercion, gender sensitivity (significant difference between women and men)	Semi-advantaged areas: the convergence of relative accessibility and environmental constraints (congestion) produces peak decision fatigue and psychological pressure.
		Advantaged areas: economic flexibility reduces cognitive load and increases the sense of control.
		Disadvantaged areas: infrastructural constraints reduce decision-making from a conscious process to a mechanical necessity.
Social and policy dimensions; social identity and self-image	Symbolic capital (Bourdieu), normative pressure, performative identity (Goffman), face management, class-based stigma	Advantaged areas: economic independence reduces the effect of social pressure, and the car has become a tool for symbolic capital and status display.
		Disadvantaged areas: decision-making is strongly influenced by social networks and normative

Analytical factor	Foundational and theoretical components	Comparative analysis of areas and the underlying mechanism
Inequalities and social injustice; spatial and experienced inequalities	Social comparison, positional knowledge, normalization of deprivation, dominant perspective, perceived gap	recommendations; fear of stigma constrains choice.
		Semi-advantaged areas: the tension between status display and regulatory restrictions has turned travel choice into an arena for managing self-image.
		Semi-advantaged areas: the perception of injustice peaks; the ability to compare with advantaged areas and positional knowledge heightens critical sensitivity.
Cultural capital and individual attitudes; social security and environmental sensitivity	Cultural capital, structural resistance, compounded insecurity, participatory frustration, trust networks, gendered risk	Disadvantaged areas: forced acceptance and the normalization of deprivation prevent the formation of acute critical awareness (except when confronting the traffic control zone scheme).
		Advantaged areas: a dominant perspective and lack of awareness of constraints minimize sensitivity to inequality.
		Advantaged areas: high cultural capital aligns with behavioral flexibility, institutional trust, and acceptance of policies.
Experience of gender- and class-based discrimination; sensitivity to gender inequality	Structural discrimination, critical sensitivity, compounded insecurity, adaptive strategies, gendered geography	Disadvantaged areas: the high factor score reflects structural resistance; insecurity (particularly for women) compels reliance on the car as a safe refuge.
		Semi-advantaged areas: participatory frustration and the absence of institutional channels for drawing on local knowledge have confined flexibility to the individual level.
		Advantaged areas: the experience of discrimination is subtle but pervasive; the higher score stems from greater critical sensitivity and lower tolerance for gendered behavior.
		Disadvantaged areas: the convergence of gender discrimination and economic deprivation produces compounded insecurity and the adoption of survival and avoidance strategies.
		Educational level: more highly educated groups critique the structural roots of the problem, whereas less-educated groups resort to individual coping strategies.

By integrating the quantitative and qualitative dimensions, the table above maps out the structural context of citizens' travel preferences across Tehran's three area types. This mixed matrix reveals clear differences in the behavioral and perceptual patterns of residents, rooted in spatial inequalities, procedural constraints, and interactional travel experiences. In the following section (discussion and interpretation of findings), these empirical results are subjected to theoretical scrutiny, and by drawing on broader theories of geography, behavioral economics, and urban justice, the underlying reasons and concrete implications of these patterns are explained.

5. Discussion and Interpretation of Findings

The integrated analysis of the findings from this mixed-methods study points to the reality that travel behavior in the Tehran metropolis is the interactive outcome of psychological, social, and structural variables. In line with the study's research question, first, the integration of the quantitative and qualitative findings shows that travel preferences in Tehran are reproduced through three distinct patterns: "choice-based/symbolic," "stress-inducing/comparative," and "forced/adaptive." In the qualitative component, the theme of "social identity and the role of self-image," and in the quantitative component, factor five (cultural capital and attitudes toward policies), show that among respondents with greater economic and cultural resources, travel is more voluntary in nature, and the private car can function as "symbolic capital." In these areas, the car serves as a tool for displaying status and managing self-image in space, which corroborates Bourdieu's theory of distinction as well as the findings of Bakhti and Situmorang (2024).

Among respondents who experience greater economic and accessibility constraints, travel behavior is more strongly shaped by structural coercion and adaptive strategies. The inferential analysis reveals that, owing to severe economic constraints, residents of these areas lack the behavioral flexibility to alter their travel patterns; even the preference for a private car in these areas stems not from luxury but from its role as a "safe refuge" against the transit insecurities of the public system (consistent with Alizadeh and Sharifi, 2023). Notably, the peak sense of relative deprivation was observed among middle socioeconomic groups (a maximum factor score of 0.9556 on factor three). Because of their intermediary geographic position, residents of semi-advantaged areas continuously compare their circumstances with those of affluent areas, which heightens their critical sensitivity and perception of injustice. This finding aligns with the theory of "relative deprivation" and with the results of Zarghamfard et al. (2023) regarding deep perceptual gaps in Tehran's spatial structure.

Regarding the consequences of unequal access, the statistical analyses of factor three (distributive inequality and injustice) and factor six (lived experience of discrimination), together with the second qualitative theme (spatial and experienced inequalities), point to a deep disconnect in access to bus rapid transit (BRT) lines and the urban rail system. The qualitative findings reveal that inequality in physical access translates directly into "inequality in the lived experience of travel." Citizens in less-advantaged areas are forced to pay intermediary transit costs (such as taxis or informal ride services) to reach the rail network or BRT lines. This structural disconnect is consistent with the findings of Azmoodeh et al. (2022) regarding the sharp decline in accessibility capability indicators on the periphery of the Tehran metropolis. Under these conditions, the implementation of pricing policies such as the traffic control zone scheme, in the absence of equitable rail and bus coverage, constitutes a clear violation of distributive justice and becomes a punitive mechanism for low-income groups, since efficient alternative options are effectively unavailable to them.

With respect to explaining the role of individual norms in transport-related behaviors, the quantitative findings from factor one (individual and perceptual characteristics), in conjunction with the first qualitative theme (psychological perception and mental engagement), demonstrate that latent psychological variables are far stronger predictors than rigid engineering variables. Severe congestion, uncertain waiting times, and poor sidewalk conditions substantially increase passengers' "cognitive load," leading to "decision fatigue" (consistent with Wieler et al., 2022). According to theories of environmental psychology (Kahneman, 2011), this mental exhaustion impedes rational and conscious travel decision-making. Individual norms are also strongly shaped by interactional and gendered security. Women's lived experiences (the fourth qualitative theme) of insecurity in transit spaces push their travel norms toward avoiding public transport or resorting to more expensive alternatives, reflecting the reproduction of gender inequalities in space (consistent with Shakibaei and Vorobjovas-Pinta, 2024).

Finally, the design of a justice-oriented framework based on the mixed-methods findings integrates the dimensions of distributive, procedural, and interactional–social justice into a coherent conceptual framework. The findings from factor two (social and policy dimensions) and factor four (urban governance), in conjunction with the fifth qualitative theme (sensitivity to policies and procedural justice), show that Tehran's traffic policies lack "procedural justice" (citizen participation and transparency). The lack of citizen involvement in formulating traffic restrictions has led to institutional distrust and the emergence of "behavioral resistance" (such as license-plate tampering within traffic control zones) (consistent with Ari et al., 2022). The justice-oriented framework produced by this mixed-methods study shows that achieving sustainable mobility in Tehran requires the alignment of distributive justice (the equitable distribution of BRT and metro lines), procedural justice (involving citizens in pricing policies), and interactional justice (reducing the cognitive burden of travel and enhancing psychological and gendered security). At the policy level, addressing this procedural gap requires establishing democratic platforms for consultation and citizen participation prior to the approval and implementation of any new traffic restrictions — a measure that could transform citizens' current "behavioral resistance" into "voluntary compliance" with transport policies.

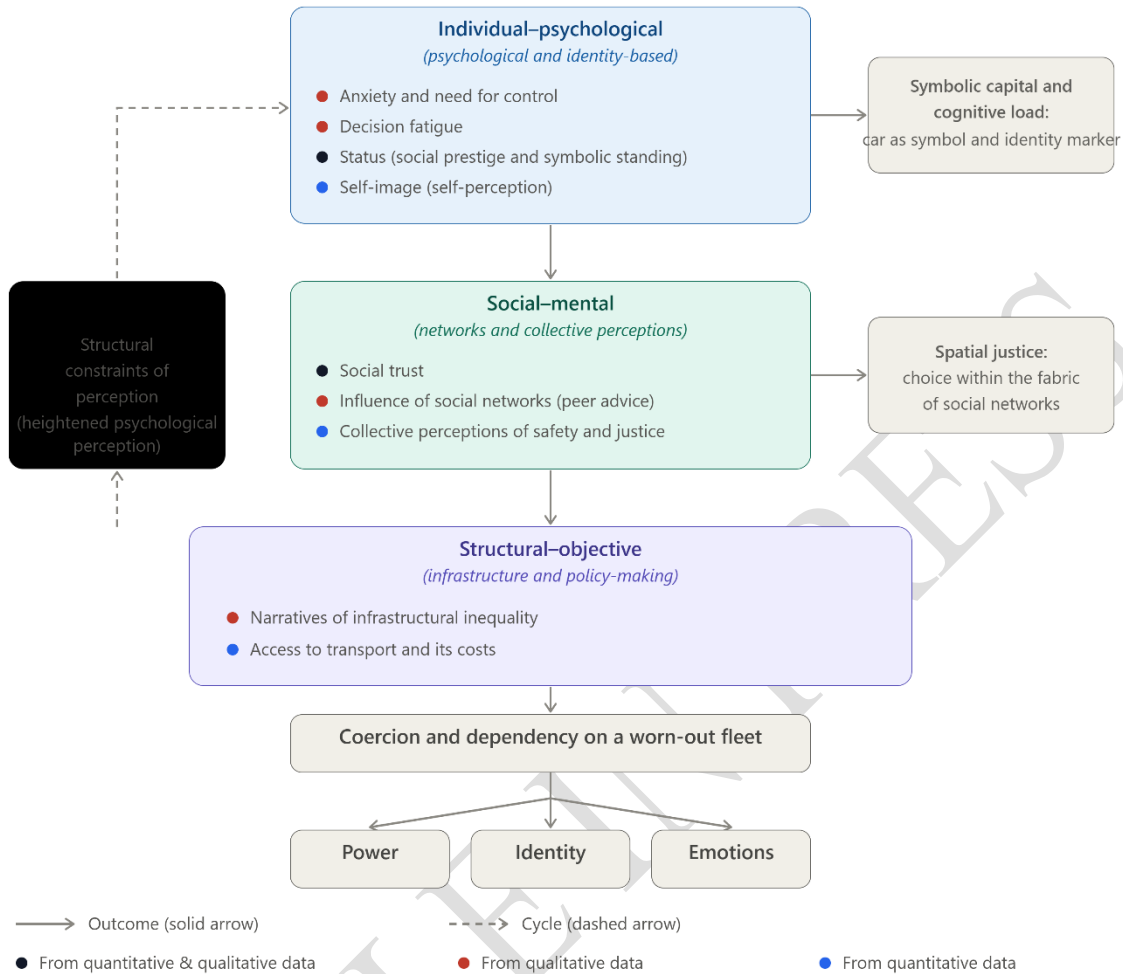


Figure 4. Integrated model of justice-oriented travel behavior

Table 7 presents a summary of the integration and correspondence between the quantitative and qualitative findings within the justice-oriented framework, showing how each major category acquired a deeper interpretation through the convergence of statistical data and lived narratives. This table confirms that concepts such as "cognitive load" and "symbolic capital" have built bridges between theory and urban reality. The resulting model derived from the findings is also presented in Figure 4. The extracted model is exploratory in nature, and its purpose is to identify the latent structure and clustering of the variables influencing travel behavior.

Table 7. Integration and correspondence between quantitative and qualitative findings within the justice-oriented framework

category	Quantitative findings	Qualitative findings	Comparative interpretation
Individual and perceptual characteristics	Extraction of a factor with high loadings (education, anxiety, route monitoring). A significant gender difference reflects women's heightened sensitivity.	Dominant narratives of decision fatigue in semi-advantaged areas; stress arising from the paradox of imperfect options (congestion versus traffic restrictions). Women's pressing need for psychological protection.	Confirmation of cognitive-load theory: the interaction of relative accessibility and environmental constraints intensifies psychological pressure and hidden gendered costs.
Economic capital and flexibility	A significant correlation between income–car ownership and private car use in advantaged areas.	Emphasis on the sense of control and predictability as core values. Use of ride-hailing apps to preserve	Financial flexibility: wealth reduces uncertainty-driven anxiety by purchasing assurance and buffering against

category	Quantitative findings	Qualitative findings	Comparative interpretation
	Positive loadings for indicators of temporal flexibility.	privacy and reduce stress.	fluctuations.
Structural constraint and coercion	Strong statistical dependence on a worn-out public transport system in disadvantaged areas; low statistical variance in choices.	Narratives of necessity and mechanical decision-making; a sense of lost agency and entrapment within existing conditions.	Structural coercion: physical constraints eliminate rational deliberation and turn travel into an imposed necessity.
Environmental quality and lived experience	High importance of physical-condition variables and peak-hour travel in explaining variance in behavior in central areas.	Bitter experiences of congestion and disorder as key drivers of psychological exhaustion and reduced satisfaction.	Environmental impact on mental health: crowding as an environmental stressor underscores the need to attend to service-quality indicators beyond travel time.
Hidden costs and cognitive load	High weight and factor loadings for anxiety and route-monitoring variables in the predictive model.	Descriptions of cognitive exhaustion and continuous pre-trip information processing (traffic, weather, parking).	Cognitive load as a hidden cost of travel: the decision-making process carries a high mental cost that is overlooked in traditional logit models (which focus on time and cost) and is consistent with newer behavioral-economics theories.
Governance and institutional gap	Low levels of awareness of sustainable policies; no significant regional difference in the acceptance of official policies.	Deep institutional distrust; policies (such as the traffic control zone scheme) perceived as class-based punitive tools and behavioral disincentives.	Institutional gap: the mismatch between policies and lived experience leads to resistance to interventions and a crisis of legitimacy.
Technology and the digital–social divide	A positive correlation between ride-hailing app use and education/income; a significant regional difference in usage patterns.	The dual role of technology: a tool for reducing uncertainty in advantaged areas, and a strategy for compensating for shortages in disadvantaged areas.	Context-dependent technology: the role of technology is shaped by social capital, highlighting the need to attend to digital justice.

The integrated analysis of this study's findings clearly shows that psychological and social variables play a key regulatory role in citizens' economic decision-making processes, and that transport policy-making therefore cannot rest solely on the logic of minimizing financial cost. For example, in the decision of working women residing in peripheral areas to travel at night, "risk perception" and the need for "psychological security" outweigh purely economic calculation (reducing fare costs) a pattern explained, in the present study's analytical model, by the interaction between the "lived experience of discrimination and security" factor and the "structural constraints" factor. This finding confirms that users, particularly vulnerable groups, are willing to pay a higher financial cost to purchase "security," "dignity," and "reduced cognitive load" a point whose neglect severely limits the effectiveness of purely price-based interventions.

Accordingly, the present study proposes four distinct, interconnected policy implications, corresponding to the four axes examined. First, in response to axis one (differences across levels of advantage), there is a need to move away from a rigid, unified pricing policy toward "distribution-based and geography-sensitive spatial justice" meaning that the toll for entering the traffic control zone should be set dynamically, in accordance with the level of advantage of the trip's originating neighborhood, the distance to the nearest metro or BRT station, and the necessary or discretionary nature of the trip. Second, in line with axis two (unequal access to public transport), the revenues generated by these pricing schemes should be transparently and purposefully directed toward developing active

transit infrastructure (particularly BRT and urban rail lines) and improving access to BRT and metro lines for more constrained groups, so as to restore the social legitimacy these policies have lost. Third, corresponding to axis three (the role of individual norms), it is necessary to design interventions aimed at reducing cognitive load and enhancing the psychological and gendered security of travel including through optimizing real-time travel information systems, improving the interactional quality of stations, and increasing social oversight to enhance women's sense of security in transit spaces. Fourth, in response to axis four (designing the justice-oriented framework), institutionalizing citizen participation through the creation of democratic consultation platforms prior to the approval and implementation of any new traffic restriction is necessary in order to transform citizens' current "behavioral resistance" into "voluntary compliance" with transport policies. These four policy implications should not be pursued separately or in isolation; rather, they need to be implemented simultaneously and in alignment, within a single integrated policy package grounded in the present study's justice-oriented framework, so that a transition to sustainable, equitable, and human-centered mobility in the Tehran metropolis can be achieved.

6. Conclusion

By integrating quantitative and qualitative data, the present study answered its central research question regarding how citizens' travel behavior is shaped through the interaction of structural, social, and psychological factors, and offered a multidimensional model explaining this behavior within Tehran's traffic control zone. The findings showed that citizens' travel behavior is not simply a function of cost and time, but is shaped by the dynamic interaction of structural constraints, psychological perceptions, and social contexts. In this light, the study's findings can be summarized across four analytical dimensions. First, differing social and spatial conditions produce distinct patterns of travel behavior among participants, such that travel behavior is, for some groups, more discretionary and based on individual preferences; for others, shaped by environmental pressures; and for yet others, driven mainly by access constraints and structural conditions. Second, psychological factors — particularly decision fatigue, perceived security, and individual norms play a decisive role in the acceptance or rejection of travel-demand management policies, and in many cases their influence exceeds that of purely technical variables. Third, the findings show that justice in transport is not limited to the distribution of infrastructure; citizens' lived experience of access, security, social standing, and travel quality also forms an important part of transport justice. Finally, the integration of the quantitative and qualitative findings led to a justice-oriented framework for explaining travel behavior, which can serve as a basis for urban transport policy-making in the Tehran metropolis.

The theoretical and scholarly contribution of this study to the transport-planning literature lies in moving beyond classical, rigid traffic-engineering approaches (such as conventional logit or route-choice models) and offering a "multidimensional behavioral-justice-oriented framework" that, for the first time, explains the dynamic interaction between objective layers (physical infrastructure) and subjective layers (cognitive load, travel anxiety, and gendered lived experiences) within the spatial context of a developing metropolis. By linking concepts from environmental psychology (Kahneman's cognitive load), urban sociology (Bourdieu's distinction and symbolic capital), and schools of justice (distributive, procedural, and interactional), this study contributes to the production of locally grounded knowledge on travel behavior within polarized spatial structures, and shows how citizens' mobility decisions are shaped not by pure economic rationality but by defense mechanisms against cognitive exhaustion and spatial inequalities.

Despite the theoretical and empirical contributions of this study, the interpretation of the findings should take into account certain methodological limitations. First, owing to the exploratory nature of the study and practical implementation constraints, the sample size in the quantitative component was limited, with 40 questionnaires sitting at the threshold of adequacy for conducting factor analysis. Although a KMO value of 0.5 and the significance of Bartlett's test confirm the feasibility of conducting factor analysis, following Zebardast (2017), the quantitative results of this component should be regarded as exploratory, direction-setting evidence for future research rather than as findings with definitive statistical generalizability. Second, the study's data were collected during May and June 2025 [Ordibehesht–Khordad 1404]; consequently, the observed patterns of travel behavior may have been influenced by seasonal conditions, transient events, changes in fuel prices and fares, or other contextual fluctuations. Third, in the qualitative component, there was potential for normative considerations and social stigma to influence participants' narratives particularly on topics such as the experience of discrimination, feelings of insecurity, or a preference for private car use. Nevertheless, to enhance the credibility and dependability of the findings, strategies such as member checking, cross-case comparison, interpretive control of the data, and independent assessment by the researchers were employed. Accordingly, the results of the present study indicate that urban transport planning needs to move beyond purely technical, one-dimensional approaches and toward an integrated policy-making process that simultaneously attends to spatial justice, gender sensitivities, the reduction of travel-related cognitive load, and the enhancement of the social standing of public transport.

Building on the findings of the present study, and in line with advancing the theoretical and empirical literature on travel behavior, spatial justice, and the lived experience of urban mobility, several avenues for future research can be proposed. First, it is suggested that the effectiveness of interventions aimed at reducing travel-related cognitive load including smart information systems, travel-time prediction tools, and integrated route-planning services be evaluated through longitudinal designs based on repeated-measures data, so as to enable the assessment of the sustained effects of these interventions on indicators such as perceived stress, travel satisfaction, sense of control, and mental health. Second, conducting comparative studies with a gender-focused approach could contribute to a more precise understanding of the consequences of security-oriented policies in public transport such as dedicated cars or spaces for the perception of security, sense of belonging, institutional trust, and travel-mode choice patterns. Third, the symbolic redefinition of public transport and the role of user-experience design in reducing the class-based stigma associated with its use represents an underexplored area warranting more serious attention. In this regard, future research could examine how improvements in environmental quality, spatial aesthetics, service legibility, the dignity of the travel experience, and the social representation of public transport might influence citizens' attitudes and mobility preferences.

Author Contributions

All authors contributed equally to the writing of this study.

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Conflict of Interest

According to the authors' declaration, there is no conflict of interest related to this article.

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