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Understanding the Failure of Restrictive Transportation Policies: A VBN-based Analysis of Cultural and Psychological Determinants of Acceptance

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ABSTRACT: Urban congestion and air pollution are persistent challenges in developing countries, often driven by high private vehicle dependency. While Transportation Demand Management (TDM) policies aim to mitigate these issues, restrictive measures such as driving bans frequently fail to gain public acceptance. Using the Value-Belief-Norm (VBN) theory, this paper investigates the factors affecting the acceptance of restrictive TDM regulations in Tehran, Iran. A total of 500 questionnaires were distributed to assess the impact of environmental awareness and cultural values on individuals' transportation choices. The study utilized Structural Equation Modeling (SEM) to evaluate short-term (1-week) and medium-term (1-month) policy scenarios. Findings show biospheric and egoistic values, awareness of consequences, personal norms, and vehicle costs significantly influence sustainable travel behavior, particularly medium-term. The results suggest that combining restrictive policies with targeted education and awareness campaigns, economic incentives, and public transit investment may enhance policy acceptance and promote sustainable mobility practices in car-dependent societies.

KEYWORDS: Transportation Demand Management (TDM), Restrictive Policy, Policy Acceptance, VBN Theory, Structural Equation Modeling (SEM)

1. INTRODUCTION

In developing metropolises, the transportation sector faces numerous challenges. In these contexts, car dependency is widely considered one of the main contributors to both air pollution and traffic congestion. Policymakers in such cities have implemented Transportation Demand Management (TDM) strategies in an effort to mitigate these negative effects. TDM refers to a range of strategies and programs designed to promote more efficient use of transportation resources and reduce car dependency. These policies can generally be categorized based on their level of coerciveness (Eriksson et al., 2006; Litman, 2013; Steg & Vlek, 1997): encouraging policies, which motivate individuals to voluntarily reduce car use, and restrictive policies, which apply disincentives to make car use less attractive (Steg & Vlek, 1997).

However, many of these efforts have proven unsuccessful. This issue has been studied in the context of developed countries for instance, (Dinh Toan et al., 2022; Dyrhauge & Rayner, 2023; Gonzalez et al., 2023; Hrelja & Rye, 2022) and also developing countries (Boso et al., 2023). In Tehran, the capital of a developing country and one of the most polluted cities in the world (Mamdoohi et al., 2016), resistance to restrictive car use policies remains high. According to previous studies, there is often a disconnect between policymakers' expectations when implementing restrictions such as the odd-even plan and public perceptions of these policies as effective solutions for reducing traffic and air pollution (Habibian & Kermanshah, 2013; Jakovcevic & Steg, 2013; Tayarani, et al., 2020a).

The odd-even plan is a traffic restriction measure that allows vehicles on the road only on alternating days, based on the last digit of the license plate number. This policy, although designed to reduce traffic and air pollution, has not yielded satisfactory outcomes in terms of behavioral change. Despite being a form of restrictive policy, it has not been successful in significantly discouraging private vehicle use.

Several factors influence the success or failure of TDM policies. One of the key determinants is public acceptance. Resistance to restrictive measures is often rooted in sociocultural factors. In some cultures, private vehicle ownership is perceived as a symbol of prestige (Mamdoohi, et al., 2013). Encouraging individuals to shift to public transportation, therefore, requires addressing these deep-rooted cultural attitudes. Furthermore, in many developing countries, public transportation systems are inadequate or inefficient. In the absence of viable alternatives, people may view restrictive policies as unfair or impractical and therefore resist them.

Previous studies have emphasized the importance of public acceptance in the successful implementation of TDM strategies. Gaining public support and cooperation is crucial, as policies with low levels of social acceptability are unlikely to be approved or enforced effectively (Ahmad & Puppim de Oliveira, 2016; Khalilikhah et al., 2016; Milenković et al., 2019; Moeinaddini & Habibian, 2024; Xianglong et al., 2016). As findings of another study shows, insufficient acceptability can lead to failure at the legislative level (Išoraitė, 2010).

Although the odd-even policy has been in place in Tehran since 2006, residents remain heavily dependent on private vehicles (Mamdohi et al., 2016). Figure 1 illustrates the level of air pollution in Tehran during the years that the Odd-even policy was being implemented (2006 to 2023). Despite ongoing implementation of the restriction, air pollution levels have not significantly declined, suggesting the policy has not been as effective as anticipated.

Over time, restrictions like these may become ineffective or even counterproductive. For example, some individuals respond by purchasing additional vehicles or motorcycles with alternate license plates, allowing them to bypass the system and maintain daily car usage (Guerra & Millard-Ball, 2017). Notably, motorcycles often emit four to eight times more pollution than cars. In other cities, such as Beijing,

similar restrictions showed initial success during events like the 2008 Olympics. However, Li et al. (2020) report that in places like Mexico City, such policies backfired, leading to worse air quality due to the acquisition of older, more polluting second vehicles.

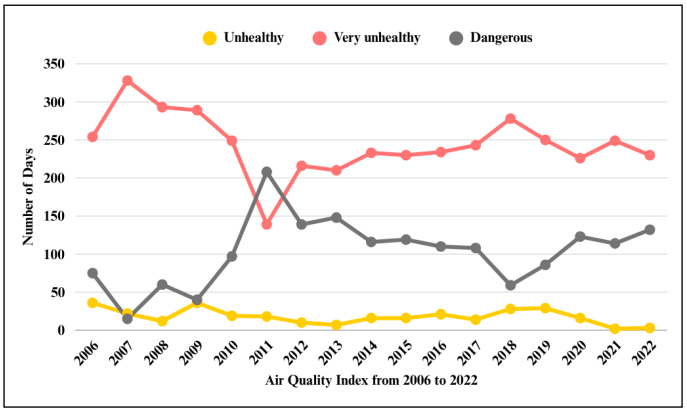

Figure 1. Air Quality index 2006 to 2022 in Tehran

According to the Iranian transportation department, Tehran alone accounted for 18.24% of national CO_2 emissions in 2018 (Mahpour et al., 2018). Furthermore, the World Bank (WHO, 2016), estimated the economic cost of Tehran's air pollution at USD 2.6 billion annually. The Iranian Ministry of Health has linked air pollution to the deaths of approximately 12,000 people per year.

A lack of public awareness about the health and environmental benefits of such policies often leads to resistance. Educating the public about the dangers of air pollution and promoting environmentally friendly alternatives are essential strategies for improving compliance (Batur & Koç, 2017; Bueno Cadena et al., 2017; Habibian & Kermanshah, 2011; Xu et al., 2015).

The effectiveness of TDM policies also depends on their design and implementation. Policies that are well-tailored to the needs and behaviors of the population tend to perform better. For example, Habibian and Kermanshah (2013) demonstrated that combining multiple policies, both encouraging and restrictive, can lead to greater effectiveness. Findings have shown that policy packages can create synergies that increase public acceptability (Diao, 2018; Habibian & Kermanshah, 2011, 2013). Another recent study in Tehran found that combining restrictive measures such as parking pricing with supportive strategies like reducing transit access time significantly improved public acceptability among car users in Tehran, particularly when the interaction effects between these policies were taken into account (Moeinaddini & Habibian, 2024). Combining restrictive policies with public education efforts may help overcome cultural resistance and structural barriers.

To better understand the behavioral mechanisms behind policy resistance, this study adopts the Value-Belief-Norm (VBN) theory. This framework explains how personal values, environmental beliefs, and internalized moral norms influence pro-environmental behavior. In this framework, values reflect enduring personal goals (e.g., environmental protection or self-interest), beliefs involve awareness of environmental consequences and one's responsibility, and norms are moral obligations that motivate pro-environmental behavior. Individuals vary in how they weigh personal convenience against environmental concerns. While some people are motivated by A sense of moral duty to act sustainably, others may believe that technological improvements alone can solve environmental problems without requiring changes in personal behavior.

Consequently, for car-restrictive policies to be sustainable, they must be accompanied by cultural adaptation over time, a process often referred to as acculturation. Behavioral change rarely occurs instantly. People may initially resist restrictions but gradually adjust their routines in response to new norms and increase environmental awareness. To examine this, the current study analyzes behavior under two timeframes: a short-term scenario (1 week) and a medium-term scenario (1 month). While short-term changes may be limited, medium-term implementation allows more time for adjustment and can result in more lasting behavioral changes.

Based on the Value-Belief-Norm (VBN) framework and the context of car use in Tehran, this study proposes that the activation of personal norms depends on cultural adaptation processes and leads to behavioral change over time. It is further assumed that an individual's socio-economic status significantly influences their decision to use private vehicles. Additionally, the study examines whether trip characteristics, such as purpose, duration, and distance, are significantly associated with behavioral change in vehicle choice.

The remaining part of this paper is structured as follows. In section 2, the literature review is presented, followed by the methodology that is presented in section 3. Results and modelling in section 4, and finally, discussion and conclusion have been presented in section 5.

2. LITERATURE REVIEW

Transportation Demand Management (TDM) aims to promote environmentally friendly transportation patterns and behaviors, either directly or indirectly. The two main categories of TDM are encouraging and restrictive policies. Recent initiatives, such as Cleveland's elimination of mandatory off-street parking near transit corridors and Colorado's tax incentives for employer-based TDM programs, exemplify innovative approaches to promoting sustainable commuting (Allard, 2023; Denver, 2024).

Measures that imply compulsion, such as charging parking fees, raising fuel prices, or restricting access for private cars, are examples of restrictive policies (Queiroz et al., 2020).

In contrast, encouraging policies aim to shift behavior by promoting public transportation, environmentally friendly cycling, or rapid transit systems (Beirão & Cabral, 2007; Bueno Cadena et al., 2017). The effectiveness of either approach depends on governance capacity, urban form, and the socio-economic context. In many cases, policies fail when they do not reflect the needs and behaviors of the local population.

In preparation for the 2008 Olympic Games, Beijing Municipality implemented odd-even policy during the event and before that to improve air quality. Interestingly it was observed that there was a reduction in pollution and congestion in Beijing as a result of the odd-even policy. Li and Guo (2016) studied Beijing during the 2008 Olympic Games, Beijing implemented the odd-even license plate policy alongside other supportive policies to improve air quality. Chen et al. (2011) found that air pollution indices dropped by 24.9% during the Olympics compared to the same period in 2007. However, subsequent studies suggest that the improvement was not due solely to the odd-even rule. Li et al. (2020) used a breakpoint regression method and found that other policies, such as public transport expansion and bans on used-car purchases, played a major role in improving air quality (Yu & Zhu, 2016). In contrast, Tehran implemented only the odd-even plan without complementary measures, which may explain its limited success.

Xie et al. (2017) analyzed the odd-even policy from an economic perspective and concluded that it yields only short-term benefits, with no significant long-term contribution to urban development. Restrictive policies are not suggested

because they are mandatory and would have opposite results after a certain period of time.

Similar outcomes were observed in Mexico, where the odd-even rule worsened air quality by encouraging households to purchase second-hand cars, often older and more polluting. This underscores the fact that restrictive policies, when implemented in isolation, may have unintended consequences, particularly in developing countries with limited alternatives.

In response to these challenges, researchers have shifted focus toward behavioral factors. Studies in Iran have examined how cultural orientation and infrastructure influence the adoption of sustainable transport. Using SEM, findings of a study showed that acculturation (i.e., internalization of environmental norms) plays a critical role in reducing car dependency, especially when supported by infrastructure improvements like sidewalks and safe crossings (Mehdizadeh et al., 2019).

Studies in the developed world show that policy effectiveness and public acceptability are influenced by values, norms, environmental beliefs, awareness, and perceived costs and benefits (Batur & Koç, 2017; Beirão & Cabral, 2007; Bueno Cadena et al., 2017; Eriksson et al., 2010). More recently, scholars have adopted the Value-Belief-Norm (VBN) theory to explain environmentally responsible behavior (de Groot & Steg, 2008; He et al., 2024; Hiratsuka et al., 2018; Kim et al., 2023; Steg et al., 2012; Tayarani, et al., 2020b; Unal et al., 2019; Farzin et al., 2024). According to VBN, pro-environmental behavior emerges through a cognitive-emotional chain: values → beliefs → personal norms → behavior (Lind et al., 2015). Values reflect enduring goals (e.g., biospheric or egoistic), beliefs refer to perceived consequences and responsibility, and norms are moral obligations to act.

Building on Schwartz's (1992) value theory, VBN research has grouped individuals based on value orientations such as convenience, ambition, justice, and environmental protection. De Groot and Steg (2008) found that biospheric and altruistic values were positively associated with environmental concern, while egoistic values were negatively associated. The New Ecological Paradigm (NEP), derived from Dunlap's work, is used to assess individuals' belief systems about the human-nature relationship (Hiratsuka et al., 2018; Jakovcevic & Steg, 2013; Mahpour et al., 2022). Individuals aware of the negative consequences of environmental degradation are more likely to feel moral responsibility and act in line with personal norms, even in the absence of external enforcement.

These components can predict individuals' behavior in terms of choosing a suitable mode of transportation during a chain path. Figure 2 presents the Value-Belief-Norm (VBN) theory framework, which outlines the psychological pathway from values to beliefs, norm activation (The process by which individuals recognize that their actions have consequences for others and feel a personal obligation to act accordingly), and resulting pro-environmental behavior. This model has been applied in various countries to study environmentally responsible actions across different cultural contexts.

These mechanisms have been applied in various cultural contexts. Ünal et al. (2019) demonstrated in Russia that individuals with strong biospheric values were more aware of car-related environmental harm and thus more accepting of restrictive policies. A study in Argentina has shown similar results, where moral obligations and activated personal norms increased policy acceptance (Jakovcevic & Steg, 2013).

In a study conducted in Tehran, researchers examined the public response to a pricing policy aimed at reducing private car use. The study found that individuals with stronger pro-environmental values were more likely to switch to buses or the subway after the policy was implemented. Those who prioritized convenience, however, remained reliant on private vehicles (Mahpour, et al., 2023).

These findings demonstrate the VBN model's predictive power. However, it is also essential to acknowledge its limitations and contrast it with alternative frameworks such as the Theory of Planned Behavior (TPB). TPB posits that behavior is guided by intention, which is in turn influenced by attitudes, subjective norms, and perceived behavioral control. TPB has been widely used to assess policy acceptability (Cools et al., 2011; Eriksson et al., 2006, 2008; Xianglong et al., 2016, Haery, et al., 2024). Recent studies have expanded TPB applications, for instance, a 2025 study in Texas incorporated moral norms and policy incentives into TPB to evaluate electric vehicle adoption intentions, finding that these factors significantly influenced consumer behavior (Pamidimukkala et al., 2025). Similarly, a 2024 study in Northern Cyprus applied TPB to public transport usage, revealing that subjective norms and perceived behavioral control positively impacted behavioral intentions (Angın et al., 2024). Compared to TPB, VBN provides a stronger normative explanation of behavior, particularly when environmental values and moral beliefs are key drivers. However, TPB offers greater flexibility in predicting a wider range of behaviors and can account for external factors such as infrastructure constraints or social pressure. Some scholars suggest that integrating both models may provide a more comprehensive understanding of policy acceptance in real-world settings (He et al., 2024).

In another Tehran-based study, Mahpour and Saeedi (2022) used SEM to show that car users' socio-economic characteristics had little impact on short- and mid-term behavior change under an odd-even plan. Instead, individuals' values and environmental concern were better predictors of their willingness to shift modes (Mahpour & Saeedi Shahrivar, 2022). Jakobsson et al. (2002) also found that income, perceived fairness, and freedom influenced attitudes toward congestion pricing.

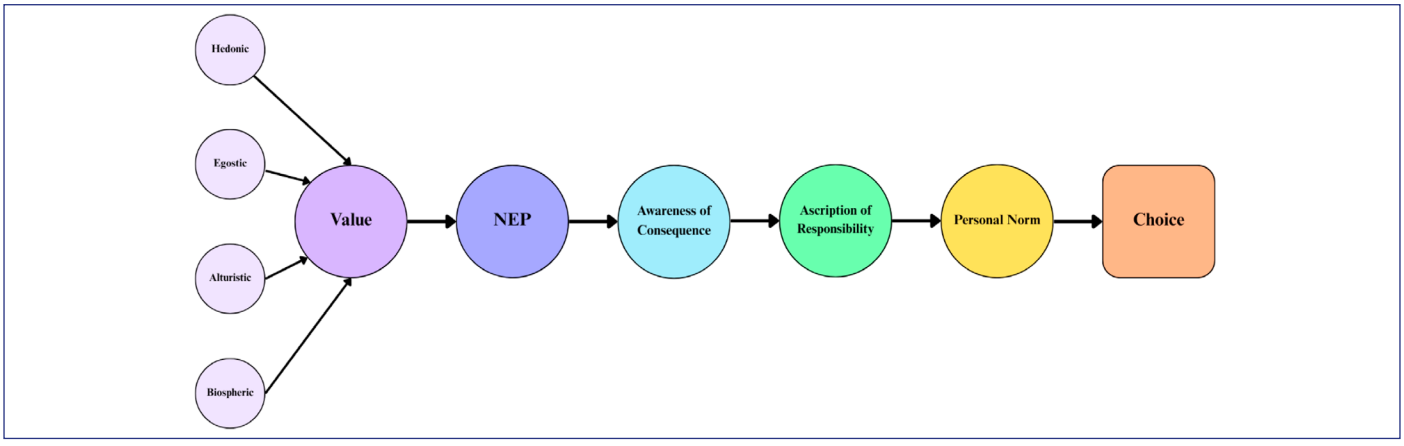

Figure 2. The VBN theory framework

Habibian and Rezaei (2017) showed that combining multiple policies (e.g., parking fees, fuel price increases, reduced access time) was more effective in influencing travel choices than implementing any single policy. This reinforces the view that policy packages tailored to context and population characteristics may offer the best results.

The literature from both Latin America and Asia confirms that environmental values and attitudes significantly affect support for restrictive transport policies (Jakovcevic & Steg, 2013).

In developing countries like Iran, a lack of awareness about long-term consequences of car use can hinder policy success, hence, educational interventions that target psychological and cultural factors are crucial (Li et al., 2020; Xie et al., 2016). As several studies suggest, environmental concern often translates into a moral stance, making car reduction a normative issue (Hiratsuka et al., 2018; Unal et al., 2019).

It can be concluded that restrictive driving policies might turn out to be effective for the minimization of pollution and congestion in the short term. Long-term effectiveness of the policy depends upon public compliance and the effective implementation of the policy. Considering this literature, the present study adopts the VBN theory to evaluate public acceptance of restrictive driving policies in Tehran over short (1-week) and medium (1-month) timeframes. Based on these findings, the following hypotheses are proposed: First, it is expected that the activation of personal norms depends on cultural adaptation and leads to behavioral change over time. Second, individuals' socio-economic characteristics may affect their likelihood of using private vehicles. Third, the characteristics of a trip, such as its purpose, length, or required flexibility, may influence behavioral changes in transport choice. These hypotheses align with earlier VBN applications while addressing the urban-cultural specificities of Tehran.

3. METHODOLOGY

This section outlines the methodological approach used to examine the behavioral effects of restrictive transportation policies within the Value-Belief-Norm (VBN) theoretical framework. It details the conceptual model, survey instrument design, data collection procedures, and the statistical techniques employed for model estimation and validation.

3.1 Conceptual Framework and Research Model

This study adopts the Value-Belief-Norm (VBN) theory as its central theoretical framework for explaining environmentally responsible behavior. The VBN theory proposes that individuals' actions are influenced by a psychological chain beginning with deeply held values, followed by environmental beliefs, which then activate personal norms that guide behavior. The values include orientations such as biospheric, altruistic, egoistic, and hedonic concerns. These values shape beliefs about human-environment relationships, particularly through awareness of the consequences of one's actions and the perceived personal responsibility for environmental issues. When these beliefs align with moral obligations, individuals are more likely to adopt sustainable behaviors.

In this study, the VBN theory is expanded by integrating two additional sets of predictors. First, socio-economic characteristics such as income, education, and car ownership are considered to explore their potential influence on private vehicle use. Second, trip-related factors such as trip purpose and companion type are included to assess the situational influences on travel behavior. Figure 3 illustrates the conceptual model that operationalizes these relationships. The model hypothesizes three main pathways: the influence of VBN constructs on behavior, the role of socio-economic factors in shaping travel decisions, and the relationship between trip characteristics and behavior change. These hypothesized pathways were derived from the theoretical discussion and empirical literature reviewed in earlier sections.

3.2 Questionnaire design

A total of 500 questionnaires were collected for this study through a field survey conducted in September 2018 in Tehran. The timing of the survey coincided with the operational period of the odd-even traffic restriction policy, ensuring participants had recent exposure to the regulated travel environment. The data collection focused on capturing behavioral and psychological responses related to travel decisions under such policy conditions.

The research employed a structured questionnaire to collect quantitative data from individuals commuting through Tehran's odd-even traffic restriction zones. The questionnaire consisted of three main sections. The first section collected demographic and socio-economic data, including gender, marital status, age, education level, employment type, monthly income, car ownership, and driving license possession. These variables were selected based on their relevance to travel behavior and are summarized in Table 1.

The second section of the questionnaire was developed to measure the latent psychological constructs outlined in the VBN theory, including value orientations, environmental beliefs, awareness of consequences, ascription of responsibility, and personal norms. Value orientations were assessed across four domains: hedonic, egoistic, altruistic, and biospheric, using a 9-point Likert scale ranging from -1 ("contrary to my values") to 7 ("extremely important"). The remaining constructs—environmental beliefs (fifteen items based on the New Ecological Paradigm), awareness of consequences, ascription of responsibility (five to six items each), and personal norms (eight items), were all assessed using a 5-point Likert scale. All items were adapted from previously validated instruments to ensure construct validity and comparability.

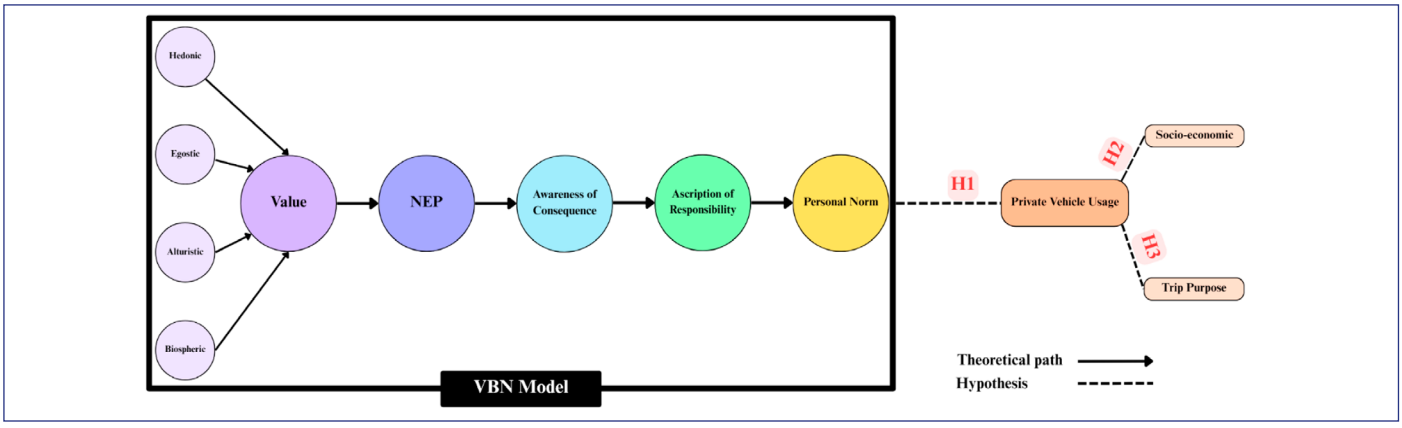

Figure 3. Conceptual model and hypothesized relationships

Table 2 presents the list of constructs, individual items, and their corresponding sources.

The third section of the questionnaire introduced two policy-based behavioral scenarios. Participants were asked to consider a hypothetical air pollution event in which odd-even traffic restrictions would be implemented. They were then presented with two scenarios: one in which the policy would be enforced for one week (short-term), and another for one month (medium-term). In each case, participants indicated how they would respond on days when their vehicle would be restricted. These questions were designed to elicit intended behavioral responses under different levels of policy exposure, and to evaluate how value-based norms and situational factors interact over time.

Prior to the main data collection, a pilot test was conducted with 40 participants to assess the clarity and reliability of the questionnaire. Internal consistency was evaluated using Cronbach's alpha, with all constructs exceeding the 0.75 threshold, indicating acceptable reliability. To address concerns about multicollinearity, variance inflation factor (VIF) values were calculated and remained below 3.3 for all constructs. Additionally, Harman's single-factor test was conducted to assess common method bias, and results confirmed that no single factor dominated the variance structure.

The data were collected in September 2018 in Tehran, Iran, using a structured on-site survey method. A total of 500 respondents were selected based on systematic intercept sampling at various points within Tehran's central business district (CBD), specifically in areas directly affected by the odd-even traffic regulation. The target population consisted of individuals traveling through these zones. Randomization was ensured by approaching every fifth individual at different times of the day and at various designated points. This strategy was implemented to minimize temporal and locational sampling bias.

Variable	Category	Absolute frequency	Relative frequency (%)
Gender	Women	213	42.6
	Men	287	57.4
Marital status	Single	200	40.0
	Married	300	60.0
Age	18-24	80	16.0
	25-34	157	31.4
	35-44	135	27.0
	45-54	76	15.2
	55-64	42	8.4
	65>	10	2.0
Education	Middle School degree	43	8.6
	High school diploma	111	22.2
	Associate	111	22.2
	Bachelor	168	33.6
	Master	58	11.6
	Doctoral	9	1.8
Job statues	Jobless	122	24.4
	Retired	26	5.2
	Government`s employee	36	7.2
	Private sector employee	99	19.8
	Self-employed	194	38.8
	Physicians	5	1.0
	Engineer	11	2.2
	Faculty member	0	0.0
	Other	7	1.4
Monthly income	10 Million Rials	15	3.0
	10-20	98	19.6
	20-30	141	28.2
	30-40	129	25.8
	40-50	89	17.8
	50-100	22	4.4
	More than 100 Million Rials	6	1.2
Number of cars	0	52	10.4
	1	334	66.8
	2	102	20.4
	3	10	2.0
	4	2	0.4
Credit licensees	Yes	437	87
	No	63	17

Table 1. Statistical analysis of socio-economic variables (Sample size=500)

Construct	Items	Reference
Hedonic value (HV)	1- Pleasure, 2- Enjoying life 3- Gratification for oneself	(de Groot & Steg, 2008; Steg et al., 2014; Steg et al., 2012)
Egoistic value (EV)	1- Social power 2- Wealth 3- Authority 4- Influential 5- Ambitious	
Altruistic value (AV)	1- Equality 2- A world at peace 3- Social justice 4- Helpful	
Biospheric value (BV)	1- Respecting the earth 2- Unity with nature 3- Protecting the environment 4- Preventing pollution	
New ecological paradigm (NEP)	1- We are getting close to limit of how many people the planet can support 2- Humans have the right to alter the natural environment in order to meet their needs 3- When people tamper with nature, the results are frequently devastating 4- Human ingenuity will guarantee that we do not destroy the planet`s ability to support life. 5- Humans are wreaking havoc on ecosystem. 6- If we simply learn how to develop them, the world has enough of natural resources. 7- Planets and animals have the same right to exist as people. 8- Nature`s equilibrium is strong enough to withstand the effects of contemporary industrial countries. 9- Humans are nonetheless subject to the rules of nature, despite our exceptional skills. 10- Humanity`s so-called "ecological crisis" has been vastly overstated. 11- Earth is similar to spaceship with limited space and sources. 12- Humans were meant to rule over the rest of nature 13- The balance of nature is very delicate and easily upset 14- Humans will eventually learn enough about how nature works to be able to control it 15- If things continue on their course, we will soon experience a major ecological catastrophe	(Dunlap et al., 2000)
Awareness of consequences (AC)	1- Car use causes exhaustion of scarce resources, such as oil 2- Car use takes up a lot of space resulting in less space for cyclists, pedestrians and children 3- Car use is an important cause of traffic –related accidents 4- Car use reduces the urban quality of life due to traffic noise and odor nuisance 5- By reducing car use the level of air pollution will decrease	(de Groot & Steg, 2008; Jakovcevic & Steg, 2013)
awareness of responsibility (AR)	1- I feel joint responsibility for exhaustion of fossil fuels by car use 2- I am jointly responsible for the problems caused by car use 3- Not just others, like the government, are responsible for heavy traffic, but me too 4- In principle, one person cannot decrease the problems of car use 5- I feel joint responsibility for the contribution of car traffic to global warming 6- My contribution to the problems of car use is negligible	
Personal norm (PN)	1- I feel personally obliged to travel in an environmentally sound way, such as by using a bicycles or public transport 2- I would be a better person if I used more often other transport modes instead of the car 3- People like me should do whatever they can to minimize their car use 4- I feel obliged to take the environmental consequences of car into account when making travel choices 5- I don`t feel guilty when I use the car even though there are other feasible transport alternatives available 6- If I buy a new car, I feel morally obliged to buy an energy-efficient car 7- I feel morally obliged to use the car as little as possible, regardless of what other people do 8- I don't feel personally obliged to use the car as little as possible	(de Groot & Steg, 2008)

Table 2. Latent variables and items

However, it is important to acknowledge a potential limitation in the representativeness of the sample. As the CBD is predominantly frequented by middle-income commuters, lower-income populations may be underrepresented in the sample.

3.3 Hypothetical Policy Scenarios

To examine behavior, change under restrictive policy conditions, two hypothetical implementation scenarios were included in the survey. The first scenario represented a short-term enforcement of the odd-even policy lasting one week. This choice was based on actual past implementations in Tehran, where, during periods of high air pollution, the policy was temporarily extended citywide beyond its regular application in the central business district (CBD). The second scenario simulated a medium-term enforcement period lasting one month. This duration was selected to capture a more sustained exposure that might lead to deeper behavioral adjustments. While one-week scenarios reflect emergency responses and potential short-term coping strategies, a one-month duration allows for the possibility of norm formation and behavioral adaptation. Longer-term scenarios, such as a full-year citywide implementation, were not considered realistic given current policy practices; although the policy is enforced year-round in the CBD, citywide enforcement over an entire year would be operationally and politically unfeasible. Therefore, the one-week and one-month durations were chosen to balance empirical relevance with policy plausibility.

In each scenario, participants were asked to indicate how they would commute on days when their vehicle would be restricted. The list of response options included switching to public transport (e.g., metro, bus), using alternative private vehicles (e.g., motorcycle, second car), or modifying trip plans (e.g., canceling or rescheduling the trip). Table 3 provides a summary of trip purposes and companionship types reported by respondents.

The companion-related variables are divided into two groups: "Single travel companion" (e.g., traveling with only a spouse or friend) and "Multiple travel companions" (e.g., traveling with spouse and child). These categories were intentionally kept separate to reflect how they were structured in the dataset and to preserve consistency with the modeling framework.

In addition to trip purposes and travel companions, participants were also asked to indicate their likely choice of transportation modes under both the short-term and medium-term policy scenarios. These responses included a range of alternative behaviors, from shifting to public transportation to relying on secondary private vehicles or modifying the timing and nature of their trips. These alternatives ranged from shifting to public transit to relying on additional private transport modes or changing travel timing. Table 4 presents the distribution of alternative travel options selected under each policy duration.

Structural Equation Modeling (SEM) is a versatile multivariate technique that builds upon the principles of multiple regression. It enables researchers to estimate and test a series of interrelated dependence relationships simultaneously (Fornell and Bookstein, 1982). Unlike traditional regression models, SEM integrates both a measurement component and a structural component, providing a comprehensive framework for testing theoretical models. The method allows researchers to visually represent hypotheses through path diagrams, connecting abstract theoretical constructs—known as latent variables—via arrows that depict their assumed causal relationships.

Latent variables are constructs that cannot be measured directly; instead, they are inferred through observable variables referred to as indicators. SEM distinguishes between two types of variables: exogenous variables, which function as independent drivers in the model, and endogenous variables, which are influenced by other variables.

Variable	Category	Symbol	Absolute frequency	Relative abundance
Trip purpose	Work	$zpurp_1$	232	46
	Education	$zpurp_2$	43	9
	Shopping	$zpurp_3$	39	8
	Recreation	$zpurp_4$	34	7
	Return Home	$zpurp_5$	139	28
	Other purposes	$zpurp_6$	13	2
Single travel companion	Father	$zham_1$	5	1
	Mother	$zham_2$	5	1
	Spouse	$zham_3$	22	4.40
	Child	$zham_4$	8	1.60
	Sister	$zham_5$	3	0.60
	Brother	$zham_6$	2	0.40
	Friend	$zham_7$	12	2.40
	Colleague	$zham_8$	8	1.60
Multiple travel companions	Father & child	$zham_{10}$	1	0.20
	Mother & spouse	$zham_{11}$	1	0.20
	Mother &sister	$zham_{12}$	2	0.40
	Spouse & child	$zham_{13}$	12	2.40
	Spouse &sister	$zham_{14}$	1	0.20
	Spouse & friend	$zham_{15}$	1	0.20
	Child &sister	$zham_{16}$	1	0.20
	Friend & colleague	$zham_{17}$	2	0.40

Table 3. Statistical analysis of daily trips information to Odd-even zone (Sample size=500)

Alternative	Absolute frequency	Relative abundance
Using personal vehicle with a payment of fees	48	10
An additional vehicle	37	7
Motorcycle	29	6
Call taxi	14	3
Street taxi	66	13
Internet-based ride-hailing	63	13
Train	134	27
Bus	47	9
Changing the way of presence in the zone	12	2
Changing the time of presence in the zone	19	4
Changing the day of presence in the zone	21	4
Cancel	10	2

Table 4. Supposed alternatives in scenario

SEM consists of two main sub-models: the measurement model, which relate observed indicators to their underlying latent constructs, and the structural model, which defines the relationships among those latent constructs. This study uses reflective measurement models, where observed variables are seen as manifestations of the underlying latent construct. In contrast, formative models assume the latent variable is formed by its indicators. The distinction is important for specifying model structure and interpreting results accurately.

Figure 4 provides an overview of the structural equations. The structural equation model can also be represented through relationships (3-1 to 3-3) (Wang & Wang, 2012).

(3-1) $\eta = \beta\eta + \gamma\xi + \zeta$

(3-2) $y = \lambda_y\eta + \mathcal{E}$

(3-3) $x = \lambda_x\xi + \delta$

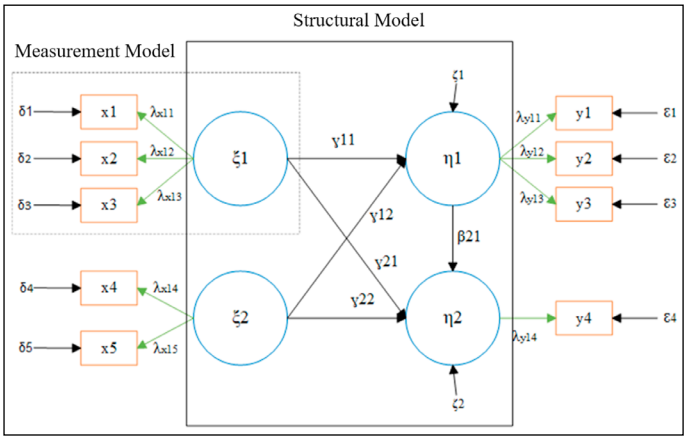

Figure 4. Structural Equation Model Representation (Wang and Wang, 2012)

The notations used in Figure 2 are addressed below:
η: Endogenous latent variables
ξ: Exogenous latent variables
y: Endogenous identifiers
x: Exogenous identifiers
Ɛ: Measurement error y
δ: Measurement error of x
β: The coefficients related to the relationship between endogenous and exogenous latent variables.
λ: The coefficients related to the relationship between latent variables and indicators.
ζ: The remainder in equations.

To evaluate the structural equation model, a range of diagnostic criteria is applied to assess its validity, reliability, and overall robustness. These criteria examine both the measurement relationships between latent constructs and their indicators, as well as the structural relationships linking the constructs themselves. Table 5 presents a summary of the principal evaluation benchmarks, including their definitions, recommended thresholds, and key references. This overview ensures clarity in the interpretation and credibility of the model results.

Criterion	Description	Acceptable Range	Key References
Outer Loadings (Factor Loadings)	Standardized path weights linking latent variables to indicators. Represent the relationship between indicators and their latent variables.	0.7 or higher (acceptable); 0.4–0.7 (carefully evaluate)	(Bagozzi et al., 1991)
Average Variance Extracted (AVE)	Indicates the average shared variance between indicators and their corresponding latent variable, assessing convergent validity.	Above 0.50	(Chin, 1998)
Cronbach's Alpha	Evaluates the internal consistency of indicators for a latent variable, assuming equal weight for all indicators.	Above 0.70	(Hair et al., 2021)
Composite Reliability	Measures reliability considering each indicator's contribution based on its significance. Indicators with higher loadings are weighted more.	Above 0.70	(Hair et al., 2021; Henseler et al., 2012)
Path Coefficients	Similar to regression coefficients, these show the impact (positive or negative) of one latent variable on another within the model.	Between -1 and +1 (statistical significance required)	(Hair et al., 2021)
Variance Inflation Factor (VIF)	Assesses collinearity among variables. A VIF value above the threshold indicates collinearity, necessitating removal of those variables from the model.	Below 5	(Hair et al., 2011)

Table 5. Evaluation Criteria for the Structural Equation Model

4. MODELING AND RESULTS

This section presents the findings of the structural equation modeling (SEM) analysis conducted to evaluate the factors influencing behavioral responses to the implementation of the odd-even traffic restriction policy. The study specifically investigates both latent psychological constructs derived from the Value-Belief-Norm (VBN) theory and observable socio-economic and trip-related variables. Previous research has shown that human behavior, including transportation choices, is shaped by complex psychological mechanisms beyond what is captured by traditional models like random utility theory (Temme et al., 2008; Walker & Ben-Akiva, 2002). By incorporating latent constructs such as values, beliefs, and personal norms, the current study aims to provide a more

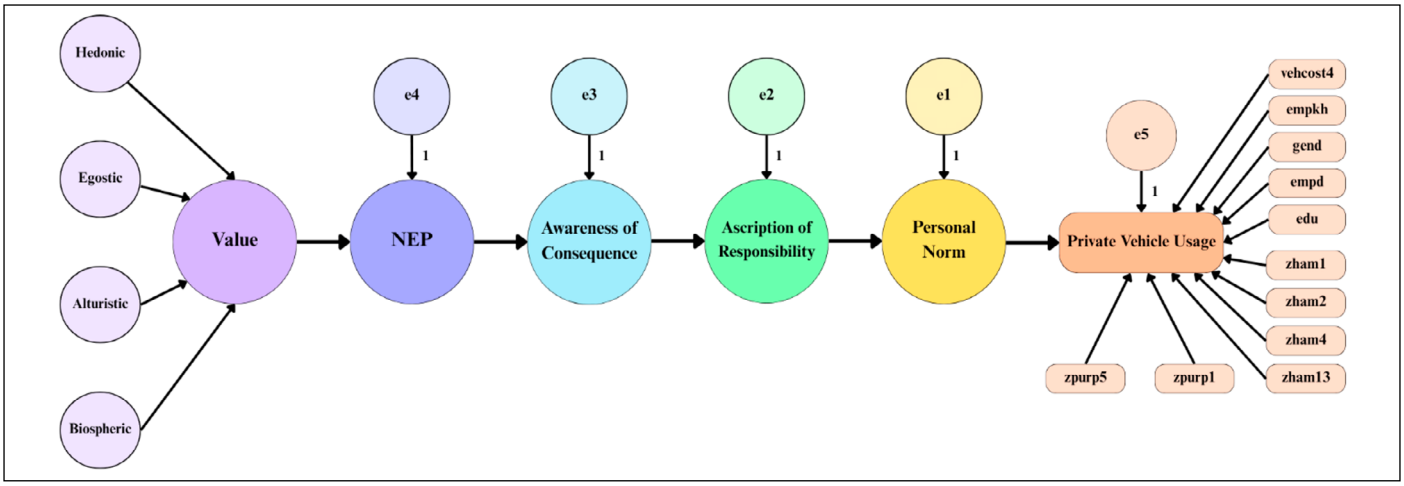

Figure 5. SEM for short term and medium term

nuanced understanding of behavioral responses under short-term and medium-term policy conditions.

To reflect the multi-layered structure of behavior, the SEM model illustrated in Figure 5 was developed. This model incorporates the hierarchical flow of the VBN theory, values influencing beliefs, which activate personal norms, and connects these latent variables to observable travel choices under restrictive traffic scenarios.

The analysis was conducted using AMOS software and applied to data collected for two policy implementation periods: short-term (one week) and medium-term (one month). In both cases, the dependent variable was binary, where the use of a private vehicle (including options such as paying the fine, using a second car, or motorcycle) was coded as 1, and the selection of alternative modes or avoidance strategies was coded as 0.

In prior studies, values have been classified into four categories: hedonic (i.e., Pleasure, enjoying life, Self-indulgent), egoistic (i.e., Social power, Wealth, Authority, Influential, and Ambitious), altruistic (i.e., Equality, a world at peace, Social justice, Helpful) and biospheric (i.e., respecting the earth, Unity with nature, Protecting the environment, Preventing pollution). As explained in the norm activity theory, environmental beliefs are composed of environmental patterns, awareness of consequences, and acceptance of responsibility. The application of VBN theory through a structural equation model provides valuable insight into the factors that influence the adoption of environmentally friendly behaviors. This study emphasizes the role of values, beliefs, and norms in shaping individuals' behavior, and suggests that targeted training can increase the likelihood of individuals to sustainable practices.

4.1 Value Orientations and Environmental Beliefs

The first phase of the model assessed the influence of value orientations on environmental beliefs, particularly the New Ecological Paradigm (NEP). Biospheric values (BV) were found to have a significant and positive effect on NEP in both the short-term and medium-term scenarios. This suggests that individuals who prioritize ecological well-being are more likely to endorse environmental worldviews, reinforcing the core assumptions of the VBN theory.

In contrast, neither altruistic values (AV) nor hedonic values (HV) showed significant relationships with NEP. Although altruism is generally associated with concern for others, its nonsignificant effect may indicate that environmental attitudes in this context are more strongly shaped by ecological or self-interested concerns than generalized social welfare.

4.2 Beliefs, Moral Responsibility, and Norm Activation

The second stage of the model focused on the relationships among environmental beliefs, awareness, and the activation of personal norms. Results show that the New Ecological Paradigm (NEP) significantly predicts awareness of consequences (AC) in both short-term and medium-term scenarios ($p < 0.001$), confirming that individuals with stronger pro-environmental worldviews are more likely to recognize the negative outcomes of car use.

In turn, AC significantly affects ascription of responsibility (AR) ($p < 0.001$), supporting the VBN sequence in which cognitive awareness precedes the acceptance of personal responsibility for environmental impacts. AR also shows a robust and statistically significant influence on personal norms (PN) across both timeframes ($p < 0.001$), reinforcing the pathway from belief to internalized moral obligation.

Despite this normative activation, the direct path from PN to behavior (vehicle choice) is not statistically significant in the short-term scenario ($p = 0.390$), suggesting that while moral norms are present, they may not yet fully translate into action under short-term policy constraints. The results further indicate that biospheric and egoistic values significantly contribute to NEP ($p < 0.05$), while altruistic and hedonic values do not. This underscores the differential role of value orientations in shaping environmental worldviews.

The significant path coefficients for NEP → AC, AC → AR, and AR → PN collectively validate the hierarchical structure proposed in the VBN framework, as illustrated in Table 6.

Variable Name	Path	Symbol	S.E	P_{value}
NEP	<	EV	0.061	**
NEP	<	AV	0.002	**0.934**
NEP	<	BV	0.066	**
NEP	<	HV	0.029	**0.260**
AC	<	NEP	0.498	***
AR	<	AC	0.685	***
PN	<	AR	0.665	***
Choice	<	PN	0.022	**0.390**
Choice	<	gend	0.115	**
Choice	<	edu_3	0.023	**0.630**
Choice	<	empkh	0.132	**
Choice	<	$vehcost_4$	0.432	***
Choice	<	empd	0.023	**0.767**
Choice	<	$zhamp_2$	0.141	**0.272**
Choice	<	$zhamp_1$	0.181	**
Choice	<	$zpurp_1$	0.041	**0.297**
Choice	<	$zhamp_{13}$	0.253	**
Choice	<	$zhamp_4$	0.393	**
Choice	<	$zpurp_5$	0.354	**

Table 6. Effective factors on changing behavior for short term

4.3 Personal Norms and Behavior Change

In the third step, the structural equation model examined the direct effects of personal norms and other explanatory variables on travel behavior under the medium-term policy scenario. Personal norms (PN) showed a statistically significant negative association with private vehicle use ($p < 0.05$), indicating that individuals with stronger moral obligations toward environmental responsibility were less likely to choose private cars during the one-month implementation of the odd-even policy. This finding supports the VBN framework's proposition that internalized moral norms drive pro-environmental behavior when sustained policy exposure allows for normative alignment.

In terms of belief structure, both awareness of consequences (AC) and ascription of responsibility (AR) remained strong mediators in the normative pathway, with highly significant effects (*$p < 0.001$). The NEP also maintained a significant impact on AC (*$p < 0.001$), reinforcing the theoretical progression from values to beliefs, norms, and behavior.

Additional socio-demographic and situational factors also demonstrated significant relationships with travel behavior. Gender ($p < 0.05$), specific trip purposes (zpurp1 and zpurp5, $p < 0.05$), and several companion types (zhamp13, zhamp4, zhamp1, all $p < 0.05$) significantly influenced the likelihood of choosing alternative transport modes. Vehicle operating cost was among the most impactful predictors ($p < 0.001$), highlighting the practical considerations that accompany normative motivations.

The results underscore that over a medium-term period, moral obligations (as reflected in PN), reinforced by environmental awareness and responsibility, can significantly shape behavioral change—particularly when supported by contextual factors such as economic cost and social setting. These findings are detailed in Table 7.

Variable Name	Path	Symbol	S.E	P_{value}
NEP	<	EV	.062	**
NEP	<	AV	.004	**0.894**
NEP	<	BV	.065	**
NEP	<	HV	.031	**0.227**
AC	<	NEP	.473	***
AR	<	AC	.685	***
PN	<	AR	.671	***
Choice	<	PN	.061	**
Choice	<	$zpurp_1$	.113	**
Choice	<	$zhamp_{13}$	.254	**
Choice	<	$zhamp_4$	.309	**
Choice	<	gend	.111	**
Choice	<	edu_3	.074	**0.101**
Choice	<	empkh	.045	**0.337**
Choice	<	$vehcost_4$	.434	***
Choice	<	emd	.127	*
Choice	<	$zhamp_1$	.138	**
Choice	<	$zhamp_2$	.139	**0.254**
Choice	<	$zpurp_5$	.255	*

Table 7. Effective factors on changing behavior for medium term

These findings emphasize the temporal nature of behavioral change: while short-term compliance may rely on external pressures or convenience, medium-term changes are more likely when internalized moral obligations are activated.

The influence of the presence of an accompanying person, particularly first-class family members, on the likelihood of using a car is quite insightful and underscores the significance of cultural factors and family dynamics in shaping transportation behavior, especially in Eastern countries.

There is a negative correlation between using private vehicles and the purpose of trip (returning home). This suggests that as the plan aimed at reducing car use is implemented, there is a decrease in the frequency of using private cars for returning home. Additionally, it appears that reducing car use was not difficult for people, as the plan was implemented in a short time. Furthermore, there is a negative correlation between private car use and the frequency of the usage less than four times a year. This implies that individuals who use their private cars less frequently are more likely to comply with the car reduction policy.

4.4 Model Fit Evaluation

To assess the overall fit of the structural models for both timeframes, several standard indices were used. The chi-square to degrees of freedom ratio (C/df) was 2.191 for the short-term model and 2.214 for the medium-term model, both within the acceptable range of less than 3. The Comparative Fit Index (CFI) values were 0.914 and 0.913 respectively, exceeding the minimum threshold of 0.90. The Root Mean Square Error of Approximation (RMSEA) for both models was 0.049, indicating a good model fit (below the 0.06 cutoff). Additional indices, including the Tucker-Lewis Index (TLI) and the Adjusted Goodness-of-Fit Index (AGFI), also met recommended standards, further confirming the models' adequacy.

Scenario name	Indices				
	RMSEA	AGFI	CFI	TLI	C/df
Short term	0.049	0.914	0.914	0.892	2.191
Medium term	0.049	0.913	0.913	0.891	2.214
Acceptable range	less than 0.06	more than 0.9	more than 0.9	more than 0.9	less than 3

Table 8. Structural equation model fit indices

The structural equation model demonstrates the central role of values, beliefs, and personal norms in influencing the behavioral response to transportation demand management policies. These psychological constructs, when integrated with socio-economic and trip-based variables, offer a comprehensive explanation of mode choice decisions under restrictive conditions. The results emphasize that targeted interventions, particularly those that elevate environmental responsibility and moral obligation, can enhance policy acceptance and encourage long-term behavioral change.

5. DISCUSSION AND CONCLUSION

This study sets out to investigate the behavioral mechanisms influencing public acceptance of restrictive transportation policies, particularly the odd-even driving restriction in Tehran, by applying and extending the Value-Belief-Norm (VBN) theory. Despite its long-term implementation since 2004, the odd-even policy has not led to substantial reductions in private car use, suggesting that non-compliance may be rooted in psychological, socio-economic, and structural factors. This research contributes to a deeper understanding of these factors by examining both internalized psychological variables and observable travel behavior under short- and medium-term implementation scenarios.

5.1 Theoretical Implications

The study empirically validates the core pathways of the VBN theory, showing that biospheric and egoistic values significantly shape environmental beliefs, which in turn foster

awareness of consequences and moral responsibility. This sequence culminates in the activation of personal norms, which were found to be predictive of behavior under the medium-term scenario. However, the absence of a significant effect of personal norms in the short-term case suggests that moral obligations may require sustained exposure to restrictive policy contexts before translating into behavioral change. These findings support the time-sensitive dynamics proposed in the VBN framework and highlight the importance of considering implementation duration when designing behavioral interventions.

Interestingly, altruistic and hedonic values did not significantly influence environmental beliefs in either timeframe. While prior research often links altruism to pro-environmental concern (Annika & Garvill, 2003), the current results suggest that, in this context, biospheric and self-interested concerns (e.g., egoistic values) may play a more dominant role. This reinforces the need for value segmentation in designing targeted awareness campaigns, whereby different segments of the population may be motivated by distinct appeals, some grounded in ecological preservation, others in personal benefit or cost reduction (Jain et al., 2021; Unal et al., 2019).

5.2 Policy-Level Implications

From a policy perspective, the findings offer several actionable insights. First, the medium-term implementation of the odd-even plan proved more effective in aligning behavioral outcomes with moral norms, underscoring the importance of duration in policy planning. Short-term or sporadic policies may fail to provide the consistency needed for norm formation and value internalization.

Second, the study found that vehicle operating cost was one of the strongest predictors of behavior. This highlights the potential of integrating economic instruments, such as congestion charges, fuel taxes, or parking fees, with normative strategies to amplify their effectiveness. In other words, policies that raise the perceived cost of private car use while also appealing to environmental values may yield more sustainable behavioral outcomes.

Third, socio-demographic factors such as gender, income, and employment sector emerged as significant determinants of behavior. Men, private sector employees, and higher-income individuals were less likely to change behavior, suggesting that these groups may require more targeted interventions. For example, flexible work hours, improved access to reliable public transport, or carpooling incentives might better align with their specific needs and constraints.

5.3 Structural Barriers and Systemic Considerations

While this study centers on psychological constructs, it is essential to recognize that structural and systemic barriers, such as limited access to safe, reliable, and affordable public transportation, can significantly constrain individuals' ability to act on their environmental values and moral obligations. Even when people express strong pro-environmental attitudes, their actual travel behavior may be dictated by situational constraints, especially in cities like Tehran, where infrastructure may not adequately support modal shift, particularly for low-income groups or households with family-based travel needs. According to Mahpour and Saeedi (2022), individuals with specific economic characteristics and trip-related obligations, such as those traveling for compulsory purposes or with companions, often show reluctance to change their travel behavior. Their findings also indicate that high-income individuals or those who find private vehicle use economically convenient may be less responsive to policy-driven incentives. These individuals tend not to perceive the financial disincentives or restrictions associated with policies like the odd-even plan as strong enough to alter their behavior unless they also possess an underlying environmental attitude. Therefore, effective policy acceptance requires more than just appealing to internalized norms; it must also involve targeted structural interventions. Policymakers should complement value-based and educational strategies with substantial investment in public transit infrastructure and equitable service provision. Only through such a holistic approach can the value-action gap be narrowed and inclusive behavioral change be achieved.

5.4 Recommendations for Policy and Practice

The findings of this study point to several important implications for urban transportation policy. First, medium-term implementation of restrictive policies appears more effective in activating personal norms and moral responsibility than short-term measures. Policymakers should therefore avoid relying solely on temporary enforcement strategies and instead design interventions that provide sufficient time for individuals to internalize behavioral changes. Sustained implementation allows for norm formation, habit disruption, and adaptation to alternative modes of travel, making pro-environmental decisions more likely and durable over time.

In addition, financial considerations play a powerful role in shaping travel behavior. Economic instruments such as higher vehicle operation costs, congestion charges, or parking fees can amplify the effectiveness of norm-based strategies by aligning individuals' economic incentives with sustainable behavior. However, such tools must be deployed carefully to avoid placing disproportionate burdens on lower-income groups. Targeted subsidies or support for public transportation can help mitigate these effects and promote greater equity.

Another key insight is the differentiated influence of value orientations. While biospheric values strongly predicted environmental concern, egoistic values also showed a significant relationship, suggesting that policy communication should not rely exclusively on ecological messaging. Instead, environmental campaigns could be strategically segmented, using biospheric appeals for those who prioritize ecological well-being and egoistic appeals for those driven by personal or financial benefit.

Finally, for individuals to make sustainable transportation choices, they must be supported by accessible and reliable alternatives. This underscores the importance of parallel investment in public transit infrastructure, especially in underserved areas. The lack of viable options is a structural barrier that undermines even the most well-designed behavioral interventions. Moreover, policies must acknowledge that travel constraints vary widely across socio-economic groups. Employment status, gender roles, and family responsibilities all influence the feasibility of changing transportation behavior. Policy design should therefore be inclusive and adaptive, promoting equity alongside sustainability.

5.5 Limitations and Future Directions

While this study provides important insights using the SEM framework, it is important to note some potential methodological limitations. First, the model does not incorporate variables such as political trust or perceived enforcement efficacy, both of which may influence individuals' willingness to comply with restrictive transportation policies. Their omission may contribute to unexplained variance in behavioral outcomes. Second, although SEM is a powerful tool for testing causal pathways, it remains vulnerable to endogeneity issues, such as reverse causality. For instance, individuals who reduce car use may report stronger personal norms to align with their behavior. Addressing these issues would require the use of longitudinal or experimental data, which were beyond the scope of this study but are recommended for future research.

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