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Developing an evaluation model for sustainable urban transportation systems with emphasis on the Tehran Metropolitan Area*

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Abstract

Transportation systems in metropolitan areas require multidimensional and context-specific evaluation models, due to the complexity of core–periphery interactions. This study develops an evaluation model for sustainable transportation systems with a particular focus on the Tehran Metropolitan Area. A mixed-methods approach was employed. In the qualitative phase, a meta-synthesis and systematic review were conducted using six national and international databases. Based on the thematic intersection of sustainability, transportation, and metropolitan areas, 41 relevant studies were selected, and their indicators were extracted. In the quantitative phase, structural equation modeling (SEM) was applied to validate the proposed model using data collected from 530 experts possessing relevant graduate-level qualifications and at least five years of professional experience in Tehran's urban management sector. The primary contribution of this study lies in shifting the unit of analysis from the "city" scale to the "metropolitan area" scale and developing a set of integrative indicators. The findings led to the identification of three dimensions, nine components, and fifty-three subcomponents. The results demonstrated a satisfactory model fit (GOF = 0.832). They revealed that the economic dimension ($\beta = 0.674$), environmental factors ($\beta = 0.481$), and the social dimension ($\beta = 0.329$) exerted the greatest influence on the evaluation model, respectively. The findings suggest that transportation policymaking in Tehran should move beyond the physical management of the core city to a regional integration approach and the strengthening of traffic-demand mitigation factors.

Keywords

Meta-synthesis
structural equation modeling (SEM)
sustainable urban transportation
sustainable urban development
system evaluation model
Tehran metropolitan area

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1. Introduction

Rapid urbanization and the emergence of large urban agglomerations have shifted the transportation management paradigm from the scale of the "individual city" to the more complex scale of the "metropolitan area" (Markarian et al., 2023). Within this context, transportation sustainability is no longer defined solely in terms of optimizing mobility within the urban core; rather, it requires establishing a dynamic balance between the core city and its surrounding satellite cities (Lee & Samimi, 2023). As a densely populated urban system, the Tehran Metropolitan Area, characterized by a substantial volume of inbound trips (exceeding four million trips per day) and a high dependence on private automobiles, represents a prominent example of regional sustainability fragmentation. In this context, core–periphery interactions generate significant traffic congestion and environmental pressures across the entire metropolitan area (Tehran Transportation and Traffic Organization, 2024; Air Quality Control Company, 2023).

Despite this interdependence, a review of the existing literature reveals a critical gap in the absence of a comprehensive and context-specific evaluation system tailored to the metropolitan-region scale. Current planning approaches are predominantly boundary-oriented and often overlook spatial interactions and intercity mobility flows in assessing transportation sustainability (IPCC, 2022). This one-dimensional perspective has resulted in three major challenges. First, there is a lack of an integrated model for analyzing mobility flows (Bushell & Marquet, 2020). Second, the indirect impacts of satellite-city expansion on land-use consumption patterns in the urban core are frequently neglected (ITF, 2023). Third, conflicts of managerial interests between the central city and surrounding municipalities hinder the formation of a regional consensus and coordinated policymaking (NACTO, 2022).

In contrast to previous studies, which have primarily focused on the physical boundaries of the central city (Mohammadpour et al., 2023), the transition toward sustainability across this metropolitan area requires a model capable of operationalizing the principles of alignment with the sustainable development goals (SDGs) and multi-level participation at the regional scale (UN-Habitat, 2022). Therefore, developing a model that evaluates sustainability across the entire Tehran Metropolitan Area, including its satellite cities, has become an undeniable necessity.

Accordingly, the present study was conducted to develop a context-specific model for evaluating sustainable urban transportation systems in the Tehran Metropolitan Area. The novelty of this research lies in extending the scope of evaluation beyond the physical structure of the city. It also proposes a model that incorporates systemic core–periphery interactions and the needs of peripheral communities as key variables in assessing transportation sustainability (Norouzi et al., 2023; Marjani et al., 2018).

2. Theoretical background

In its modern interpretation, sustainability has evolved from a purely ecological concept into a multidimensional paradigm that addresses the interactions among social, economic, and environmental systems (Hirai & Kumim, 2022). Within the field of urban management, this concept has been redefined through the model of sustainable development, emphasizing the need to balance the current needs of citizens with the rights and opportunities of future generations (Hosseini et al., 2024; Tani et al., 2024). In this context, transportation systems are no longer regarded merely as mobility tools; rather, they are recognized as catalysts for spatial organization and fundamental drivers of sustainable development, operating in a manner that safeguards public health and remains compatible with renewable resources (OECD, 1994; Aghaei, 2023).

A broad consensus within the literature suggests that the evaluation of transportation sustainability requires maintaining a dynamic balance among three key dimensions, which constitute the conceptual foundation of the present study (Goldman & Gorham, 2006; Eskandari Sani et al., 2019):

1. Economic dimension: This dimension focuses on system efficiency, the reduction of operational costs, and the role of transportation in strengthening urban and regional economies (Shao et al., 2022).

2. Social dimension: This dimension encompasses equity in accessibility, improvements in safety, urban vitality, and the enhancement of citizens' quality of life throughout the urban area (Pamucar et al., 2022).

3. Environmental dimension: This dimension emphasizes the reduction of air pollution and greenhouse gas emissions, as well as the conservation of natural resources through the expansion of public transportation and the adoption of innovative technologies (Diao, 2019; Peterson et al., 2021).

Nevertheless, achieving these objectives at the metropolitan area scale involves additional complexities. The rapid growth of population and the emergence of satellite cities surrounding metropolitan areas were initially intended to promote decentralization. However, the strong dependence of these settlements on the central city for employment opportunities and essential services has generated extensive commuting flows, undermining the sustainability of the principal gateways into metropolitan centers (Norouzi et al., 2023b; Sertiak et al., 2023). Consequently, transportation sustainability in metropolitan areas can no longer be viewed as a boundary-based issue. Rather, it requires regional integration and the optimal distribution of services across the functional hierarchy of the territory to reduce the necessity for compulsory travel (Norouzi et al., 2023a).

A review of previous studies indicates that existing evaluation models are often one-dimensional or primarily focused on the characteristics of individual cities (Marzi et al., 2022; Parsian, 2022). Therefore, given the structural characteristics of the Tehran Metropolitan Area, the development of a context-specific evaluation model capable of assessing the interrelated effects of economic, social, and environmental variables within a core–periphery context represents both a theoretical and a practical necessity. Accordingly, the following sections present the model derived from these theoretical foundations and validated through expert consultation.

3. Materials and methods

This applied study employed a mixed-methods approach with an exploratory instrument-development design. In the qualitative phase, the meta-synthesis method was employed to identify the dimensions and components of the sustainable urban transportation system evaluation model based on the dimensions of sustainable urban development and to develop the corresponding conceptual model. In the quantitative phase, structural equation modeling (SEM) was employed to validate the developed conceptual model, prioritize the identified dimensions and components, and further refine the proposed model.

In the first stage of the study, the categories related to the evaluation of sustainable urban transportation systems were identified through a meta-synthesis approach. To achieve the research objectives, the seven-step meta-synthesis model proposed by Sandelowski and Barroso (2006) was adopted (Figure 1).

Figure 1. Seven-step meta-synthesis model

The first step in the meta-synthesis process involved formulating the research questions. These questions were developed based on four key parameters: What, who, when, and how. The study aimed to classify and analyze the various dimensions of sustainable urban transportation system evaluation in the Tehran Metropolitan Area. Accordingly, four principal research questions were formulated:

1. What are the fundamental categories and underlying components of an urban transportation system evaluation model based on sustainable development indicators?

2. Which stakeholders play a role in developing an urban transportation system evaluation model based on sustainable development indicators?

3. Have relevant studies been produced and published during the period from 2000 to 2023 (1390–1402 in the Iranian calendar)?

4. How are the categories of the urban transportation system evaluation model based on sustainable development indicators interrelated?

In the second step, a systematic search was conducted across major national databases (Magiran, SID, and Noormags) and international databases (Scopus, ScienceDirect, and Web of Science). The search employed a combination of keywords, including "sustainable transportation," "metropolitan area," "sustainable transport indicators," and "metropolitan area." The target population in this phase consisted of all studies published between 2000 and 2023.

The screening process was carried out in three stages. First, more than 200 publications containing the selected keywords were identified. Second, through an examination of abstracts and overall content, studies focusing exclusively on technical transportation issues without incorporating evaluation models or sustainability perspectives were excluded, reducing the number of eligible sources to 43. Third, these 43 studies were carefully analyzed using the Critical Appraisal Skills Programme (CASP) quality assessment tool. Studies were required to obtain a minimum score of 21 out of 50 to be included in the final analysis. Ultimately, 41 sources (25 national and 16 international studies) met the eligibility criteria and were selected as the final sample for code extraction (Table 1).

In the fourth step, the findings of the selected studies were organized into a classification matrix. This matrix included three categories of information: 1) bibliographic information, including title, author(s), and year of publication; 2) key methodological information, including research objectives and methods; and 3) principal findings and conclusions.

In the fifth step, themes emerging across the studies included in the meta-synthesis were identified and analyzed. Initially, all factors extracted from the reviewed studies were treated as individual codes. Subsequently, codes with similar meanings were grouped into common concepts, and conceptually related concepts were further categorized into explanatory themes. Through this process, the principal and subsidiary categories constituting the evaluation indicators of sustainable urban transportation systems were identified.

The meta-synthesis analysis ultimately led to the development of a conceptual model for evaluating sustainable urban transportation systems based on the dimensions of sustainable urban development.

Table 1. Characteristics of studies included in the meta-synthesis process

No.	Title	Author(s)	Type	Year
1	Urban livability in line with urban social sustainability (case study: Mashhad Metropolis)	Sadeghi, Shakermi, & Jeydari Nesar	Article	2022
2	Evaluation of urban transportation conditions	Abedi	Article	2022
3	Assessment of sustainable urban transportation development	Sattarinia, Dehghan, & Asraei	Article	2022
4	Examining the role of transportation in sustainable urban economic development	Davood Hamidi	Article	2021
5	The role of transportation in sustainable development	Jahanipour Saghezabadi & Moeiri	Article	2021
6	Analysis and evaluation of urban transportation toward achieving strategic sustainable development policies	Shishegar	Article	2021
7	Evaluation of sustainable urban transportation indicators (case study: Shiraz)	Heydari	Article	2021
8	Transportation and sustainable development	Sarikhani	Article	2021
9	Review of macro-level public transport policies in Tehran	Shirazi	Article	2020
10	Sustainable urban transportation	Fattahi	Article	2020
11	Analysis and ranking of urban areas based on urban environmental unsustainability indicators using the integrated SAW and Shannon entropy model (case study: Alborz Province)	Emadoddin, Ariankia, & Baddast	Article	2020
12	Analysis of Factors affecting the human environment of Tehran based on the DPSIR model	Shahi, Zabardast, Salehi, & Salehi	Article	2019
13	Developing management strategies for the impacts of commuting from satellite cities to Tehran through toll collection mechanisms	Tehran Urban Studies and Planning Center	Research project	2018
14	Tehran–Karaj urban region transportation organization plan	Ministry of Roads and Urban Development Research Center	research project	2018
15	Feasibility study of establishing and operating a bus rapid transit (BRT) system on the Tehran–Karaj corridor	Urban Transportation and Traffic Organization	Research project	2018

No.	Title	Author(s)	Type	Year
16	Rail connectivity between satellite towns and parent metropolises: Requirements and constraints	Tehran Urban Studies and Planning Center	Research project	2017
17	Assessment and analysis of sustainable urban transportation indicators	Sahhadi & Taghvaei	Article	2016
18	Evaluation and analysis of livability components in Tehran metropolis	Mousavinour, Varesi, & Mohammadi	Article	2016
19	Urban sustainable development and its effects on economic and social growth	Azizian, Gharibi, Kariminejad, & Shanvazlou	Article	2015
20	Assessment of urban transportation and its contribution to sustainable urban development	Rasouli, Ghoranjik, & Ghoranjik	Article	2015
21	Sustainable development indicators in transportation planning	Ahadi, Zarghami, & Aghamohammadi	Article	2014
22	Urban livability in the context of sustainable urban development: Case study of Tehran Metropolis	Sarabi Sasanpour, Toulaei, & Jafari Asadabadi	Article	2014
23	Determining sustainable development density based on environmental carrying capacity with emphasis on road capacity (case study: District 9 of Mashhad Municipality)	Rahnama & Gholizadeh	Article	2014
24	Managerial challenges in developing a sustainable transportation system in Tehran	Fotouhi	Thesis	2012
25	Environmental sustainability assessment in urban areas using the linear assignment multi-criteria decision-making method (case study: Bandar Torkaman)	Hosseinzadeh, Khosravi Beigi, Mostafa Istegoldi & Shamsoddini	Article	2011
26	Comprehensive evaluation model of the urban low-carbon passenger transportation structure based on DPSIR	Li, Zhan, Wang, & Pan	Article	2023
27	Can smart cities bring happiness to promote sustainable development? Contexts and clues of subjective well-being and urban livability	Chen	Article	2023
28	Evaluation of the barriers to the use of sustainable transportation systems in city logistics with an integrated grey DEMATEL-ANP approach	Durmaz & Budak	Article	2023
29	Urban transportation networks' resilience: Indicators, disturbances, and assessment methods	Serdar, Koç, & Al-Ghamdi	Article	2022
30	A decision support system for assessing and prioritizing sustainable urban transportation in the Metaverse	Deveci, Mishra, Gokasar, Rani, Pamucar, & Ozcan	Article	2022
31	Exploring the resilience assessment framework of urban road networks for sustainable cities	Liu, Chen, Liu, & Hu	Article	2022
32	Evaluating performance of public transport networks by using public transport criteria matrix analytic hierarchy process models—Case study of Stonnington, Bayswater, and Cockburn public transport network	Lin, Wang, Lin, Bu, & Xu	Article	2021
33	Ensuring sustainable development of urban public transport: A case study of the trolleybus system in Gdynia and Sopot	Wolek, Wolanski, Bartlomiejczyk, Wyszomirski, Grzelec, & Hebel	Article	2021
34	Sustainability assessment of public transport, part I—A multi-criteria assessment method to compare different bus technologies	Ammenberg & Dahlgren	Article	2021
35	Sustainable mobility scale: A contribution to sustainability assessment systems in urban mobility	Bebber, Libardi, Moschen, da Silva, Fachinelli, & Nogueira	Article	2021

No.	Title	Author(s)	Type	Year
36	Sustainable development path research on urban transportation based on synergistic and cost-effective analysis: A case of Guangzhou	Jiao, Huang, Liao, & Zhao	Article	2021
37	System dynamics analysis of the relationship between transit metropolis construction and sustainable development of urban transportation—case study of Nanchang City	Xue, Cheng, Wang, An, & Guan	Article	2020
38	Sustainable development of urban rail transit networks: A vulnerability perspective	Shi, Wen, Zhao, & Wu	Article	2019
39	A method for the evaluation of urban freight transport models as a tool for improving the delivery of sustainable urban transport policy	Kaszubowski	Article	2019
40	Sustainable transportation	Gudmundsson, Hall, Marsden, & Zietsman	Book	2016
41	Modelling sustainable transportation systems	Yevdokimov & Mao	Article	2002

In the sixth step, to ensure that the interpretation of the meta-synthesis findings was not influenced by researcher bias, inter-coder reliability was assessed through an independent evaluator. Using MAXQDA software, Cohen's Kappa coefficient was calculated based on seven selected sources (four national and three international studies).

Following the extraction of indicators and components, the developed conceptual model was subjected to expert validation. The model was distributed to 28 specialists and practitioners in urban planning, transportation, economics, social sciences, and environmental studies who were actively engaged in the Tehran Metropolitan Area. Based on their evaluations, the content validity ratio (CVR) and content validity index (CVI) were calculated.

Two criteria were used to identify eligible experts: 1) Possession of at least a master's degree, and 2) a minimum of 15 years of professional experience. Expert selection was conducted using the snowball sampling technique; initially, 15 experts (three from each specialization) were identified. Additional participants were subsequently recruited through referrals from the initial experts until no new qualified individuals were identified. At that point, the expert panel was considered complete. Table 2 presents the educational background and professional experience of the participating experts.

Table 2. Educational background and professional experience of experts participating in the survey

Area of expertise	Master's degree (15–20 yrs)	Master's degree (20–25 yrs)	Master's degree (25–30 yrs)	Master's degree (>30 yrs)	PhD (15–20 yrs)	PhD (20–25 yrs)	PhD (25–30 yrs)	PhD (>30 yrs)	Total
Urban planning/urban design	6	0	0	0	1	1	0	0	8
Transportation planning/ transport engineering	3	0	0	0	1	2	1	0	7
Social sciences	1	0	0	0	3	0	0	0	4
Economics	0	0	0	0	2	0	1	0	3
Environmental sciences	2	1	0	0	1	1	0	1	8
Total	12	1	0	0	8	4	2	1	28
Grand total	13				15				

To identify the target population in the quantitative phase, the legal and institutional frameworks governing transportation management in Iran were first examined. According to the "Law on the Development of Public Transportation and Fuel Consumption Management" and the "Law on Supporting Urban and Suburban Rail Transportation Systems," the Municipality of Tehran is recognized as the primary authority responsible for developing, operating, and managing transportation systems within the Tehran Metropolitan Region. Accordingly, specialists and professionals working within Tehran Municipality in the fields of urban planning, transportation, economics, social sciences, and environmental studies were identified as the study population.

Based on records obtained from the Human Resources Department of Tehran Municipality and considering the inclusion criteria of holding at least a bachelor's degree and possessing a minimum of five years of relevant professional experience, approximately 12,000 individuals were identified as the target population. Given the multidisciplinary nature of the study population, stratified random sampling was employed to ensure adequate representation of all professional groups and organizational units. In this approach, the population was first divided into professional strata, and eligible participants were then randomly selected from each stratum.

To determine the appropriate sample size, the sample-to-observed-variable ratio commonly recommended for structural equation modeling (SEM) was adopted. According to the recommendations of Bentler and Chou (1988), Nunnally and Bernstein (1992), and Stevens (1999), a ratio of five to ten observations per measured variable was considered acceptable for relational analyses (Hooman, 2023; Kline, 2010). Given that the data collection instrument contained 53 measurement items, a sample size of 530 respondents was determined to minimize standard errors and ensure adequate statistical power for SEM analyses.

To ensure compliance with ethical research principles, the questionnaire began with a comprehensive explanation of the study objectives, the voluntary nature of participation, and the procedures for data management and confidentiality. Participants were informed of the study requirements before completing the questionnaire, and submission of the completed questionnaire was considered an indication of informed consent. Furthermore, respondent identities remained completely anonymous throughout the study, and confidentiality was maintained during all stages of data collection, processing, and analysis.

The collected data were subsequently used to validate the conceptual framework and rank the identified components within the proposed evaluation framework for the Tehran Metropolitan Area transportation system.

Data were collected using a researcher-developed questionnaire consisting of 53 items. The instrument was designed to evaluate the sustainable urban transportation system framework based on the dimensions of sustainable urban development in the Tehran Metropolitan Area. The questionnaire measured three principal dimensions: The economic dimension (items 1–21), the social dimension (items 22–34), and the environmental dimension (items 35–49); the final four items collected respondents' demographic information, including gender, educational attainment, professional specialization, and work experience.

All substantive items were measured using a five-point Likert scale ranging from "strongly agree" (5) to "strongly disagree" (1). Accordingly, total scores ranged from 49 to 245, with higher scores indicating a greater contribution of the corresponding factors to the evaluation of sustainable urban transportation systems.

The psychometric properties of the questionnaire were assessed through expert review and partial least squares structural equation modeling (PLS-SEM). Content validity was established through three rounds of the Delphi technique involving eight academic experts and specialists in related disciplines. The instrument demonstrated satisfactory content validity, with a content validity ratio (CVR) of 0.71 and a content validity index (CVI) of 0.93. Reliability and construct validity were subsequently examined during measurement model assessment and were confirmed. Detailed results are presented and discussed in the findings section.

Following data collection, all responses were entered into SPSS version 26 and SmartPLS version 3.2 for statistical analysis. Both descriptive and inferential statistical techniques were employed.

Inferential analyses included the one-sample Kolmogorov–Smirnov test to assess the normality of variable distributions, the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy, and Bartlett's Test of Sphericity to evaluate the suitability of the data for factor-based analyses and to examine the relationships among model variables.

Structural equation modeling was performed using the partial least squares (PLS) approach. Given the reflective nature of the measurement model, the analysis was conducted in three stages:

1. Assessment of the measurement model;
2. Assessment of the structural model; and
3. Assessment of the overall model fit.

Before evaluating the structural model, the issue of collinearity among predictor constructs was examined. For this purpose, the variance inflation factor (VIF) was used as an indicator of multicollinearity. In PLS-SEM, VIF values of 5 or higher indicate the potential presence of problematic collinearity (Mohsenin & Esfidani, 2017).

4. Results

In the qualitative phase of the study, categories associated with evaluating sustainable urban transportation systems were identified through a meta-synthesis approach. Analysis of the selected literature resulted in the extraction of a hierarchical structure comprising three principal dimensions (economic, social, and environmental), nine sub-dimensions, and a total of 53 sub-components (presented in Table 3). These sub-components were identified as operational indicators for assessing transportation sustainability within the Tehran Metropolitan Area.

Table 3. Categories extracted from the meta-synthesis analysis process

Sustainable development dimensions	Components	Sub-components	Number of sources
Economic	Direct and indirect costs	Average travel time within the core metropolis	4
		Average travel time on the intercity network	2
		Vehicle-kilometers traveled (VKT) by private vehicles	2
		Average travel speed of private vehicles within the network	2
		Average travel speed of public vehicles within the network	2
		Percentage of the network operating under congested or critical conditions	5
		Infrastructure construction costs	5
		Fleet procurement costs	3
		Infrastructure maintenance costs	2
		Fleet maintenance costs	3
		Transportation system dynamism	2
		Prevention of citizens' time loss due to inefficient urban transportation	5
	Economic welfare	Increase in public capital	4
		Economic productivity	7
		Tax reduction	2
		Efficient pricing mechanisms	2
		Improvement of public welfare and urban quality of life	6
		Foreign exchange and monetary savings resulting from reduced fuel consumption	2
	Energy consumption	Per capita daily fuel consumption (gasoline and CNG)	4
		Share of renewable energy sources in transportation	4
		Consumption of energy carriers (gasoline and diesel)	6
		Consumption of energy carriers (CNG)	2

Sustainable development dimensions	Components	Sub-components	Number of sources
Social	Travel safety	Urban traffic accident rate per 100,000 population	3
		Number of urban traffic fatalities	4
		Urban traffic injury rate per 100,000 population	2
		Number of urban traffic injuries	2
		Share of speeding violations on urban roads (%)	2
		Share of speeding violations on intercity roads (%)	2
		Accurate and safe mobility supported by advanced technologies	4
	Equity and accessibility	Total number of trips destined for the core metropolis	2
		Modal share of public transportation in motorized trips	3
		Share of population with acceptable access to public transportation	4
		Accessibility and service quality of public transportation for persons with disabilities	5
		Ease of use of transportation systems	2
		Share of cycling and walking trips in daily travel patterns	3
		Improvement of public transportation systems in metropolitan and suburban areas	4
		Reduction of severe traffic congestion and urban crowding	7
		Provision of transportation facilities and physical infrastructure	4
Environmental	Resource consumption	Land converted and occupied for project development outside the core metropolis	2
		Land converted and occupied for project development within the core metropolis	2
	Human health and well-being	Reduction of accidents and physical injuries	2
		Promotion of human-centered transportation	2
		Increase in physical activity levels	2
	Environmental compatibility	Mitigation of climate change impacts	4
		Reduction of air pollution	4
		Reduction of noise pollution	2
		Reduction of water pollution	2
		Preservation of the environment for future generations	2
	Pollutant emissions	Emissions of climate change-related pollutants (CO_2) from the transportation system	5
		Emissions of conventional air pollutants (NOx, SOx, PMx, etc.) from the transportation system	2
		Water pollutants generated by transportation activities (per capita liquid vehicle waste)	2
		Proportion of population exposed to high levels of noise pollution	3
		Number of unhealthy, very unhealthy, and hazardous air-quality days per year	2

The findings of the meta-synthesis indicated that the economic dimension consists of three major components: Direct and indirect costs, economic welfare, and energy consumption. The direct and indirect cost component includes indicators such as average travel time within the metropolitan core, average travel time on the intercity network, vehicle-kilometers traveled by private vehicles, average travel speeds of private and public vehicles, the proportion of the network operating under congested or critical conditions, infrastructure construction costs, fleet procurement costs, infrastructure maintenance costs, fleet maintenance costs, transportation system dynamism, and the prevention of citizens' time loss caused by inefficient transportation systems.

The economic welfare component encompasses indicators related to public capital enhancement, economic productivity, tax reduction, efficient pricing mechanisms, improvement of public welfare and urban quality of life, and savings in domestic and foreign currency expenditures resulting from reduced fuel consumption. The energy consumption component includes per capita daily fuel consumption (gasoline and CNG), the share of renewable energy sources in transportation, and consumption levels of gasoline, diesel, and compressed natural gas.

The social dimension consists of two primary components: travel safety and equity and accessibility. Travel safety is measured through indicators such as urban traffic accident rates, accident-related fatalities and injuries, the rate of injured persons per 100,000 population, the share of speed-limit violations on urban and interurban roads, and the provision of safe and precise mobility through advanced technologies.

The equity and accessibility component includes indicators such as the total number of trips destined for the metropolitan core, the modal share of public transportation, the proportion of the population with acceptable access to public transportation services, accessibility and service quality for persons with disabilities, ease of using transportation systems, the share of walking and cycling trips, improvement of metropolitan and suburban public transportation systems, reduction of severe congestion, and the provision of transportation facilities and infrastructure.

The environmental dimension comprises four components: Resource consumption, human health and well-being, environmental compatibility, and pollutant generation. Resource consumption includes land acquisition and land-use conversion associated with transportation projects, both inside and outside the metropolitan core. Human health and well-being are represented by indicators related to accident reduction, promotion of human-centered transportation, and increased physical activity.

Environmental compatibility encompasses indicators associated with climate-change mitigation, reductions in air, noise, and water pollution, as well as environmental protection for future generations. Finally, pollutant generation is measured through greenhouse gas emissions (CO_2), conventional air pollutants (NOx, SOx, PMx, etc.), water pollutants generated by transportation systems, the proportion of the population exposed to high noise levels, and the number of unhealthy, very unhealthy, and hazardous air-quality days per year.

To ensure the objectivity and reliability of the coding process, an inter-coder agreement assessment was conducted. Seven sources were randomly selected and independently coded by a second evaluator who was not part of the research team. The results presented in Table 4 indicate that Cohen's Kappa coefficient exceeded 0.70 for all evaluated sources, demonstrating a high level of agreement and confirming the reliability of the coding process.

Table 4. Cohen's Kappa coefficients for inter-coder agreement

Source language	Source no.	Number of codes identified by primary coder	Number of codes identified by the secondary coder	Number of shared codes	Cohen's Kappa coefficient
Persian	4	7	6	5	0.885
Persian	13	4	6	4	0.969
Persian	16	6	6	5	0.969
Persian	22	7	5	5	0.969
English	28	7	8	6	0.885
English	31	3	4	3	0.969
English	39	6	7	5	0.885
Average Cohen's Kappa coefficient across the seven sources					0.933

The results showed that the Kappa coefficients for all seven evaluated sources, as well as the overall average coefficient, exceeded the accepted threshold of 0.70. Therefore, the reliability and consistency of the coding process were confirmed. The primary outcome of this stage was the development of the conceptual evaluation model presented in Figure 2.

To transform the conceptual model into a measurable structural model, each of the 53 sub-components identified during the qualitative phase was operationalized as an individual item in the questionnaire. To establish content validity, the proposed model was reviewed by 28 academic experts and practitioners specializing in urban planning, transportation, economics, social sciences, and environmental studies within the Tehran Metropolitan Area.

The validation results indicated that both the content validity ratio (CVR = 0.73) and the content validity index (CVI = 1.00) exceeded the minimum acceptable thresholds (CVR = 0.35 and CVI = 0.75), confirming the adequacy of all dimensions and components included in the model.

This validation process bridged the gap between the qualitative findings and quantitative modeling procedures. Specifically, each of the 53 expert-validated sub-components was incorporated into the structural equation model (SEM) as an observed variable, while the identified dimensions and components were treated as latent constructs. Consequently, the final SEM structure emerged directly from the meta-synthesis findings and expert validation process, providing the foundation for the quantitative analyses reported in the subsequent section.

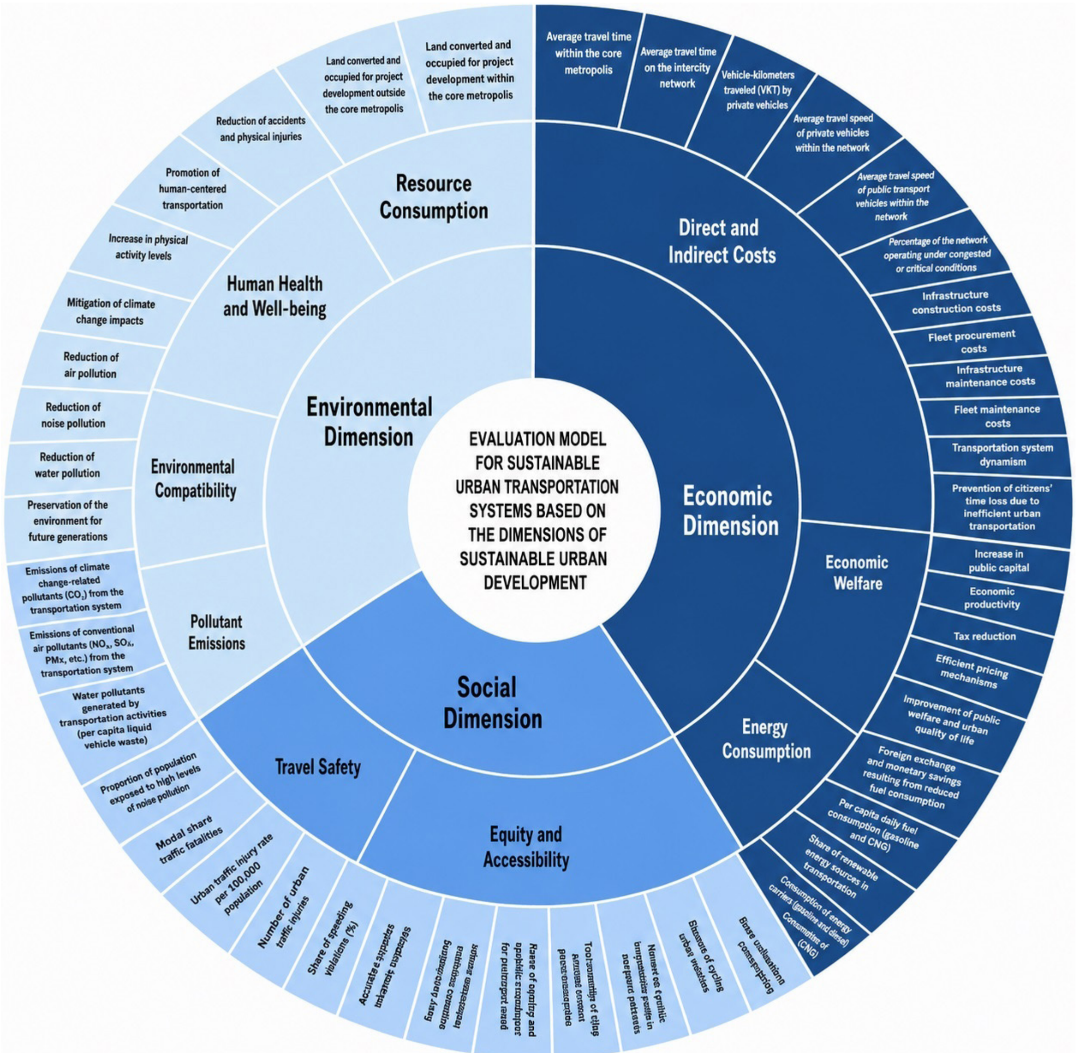

Figure 2. Conceptual model for evaluating sustainable urban transportation systems based on the dimensions of sustainable urban development

Quantitative findings: Validation of the proposed model and prioritization of dimensions and components

Because individual and professional characteristics may influence perceptions, attitudes, and expectations regarding transportation systems, an examination of respondents' demographic characteristics was conducted before model evaluation. Among the 530 participants included in the quantitative phase, 67.6% were male and 32.4% were female. Regarding educational attainment, 14.3% held a bachelor's degree, 63.1% held a master's degree, and 22.6% possessed a doctoral degree. In terms of professional specialization, 28.2% were affiliated with urban planning and urban development, 40.7% with transportation and transit planning, 5.4% with economics, 8.1% with social sciences, and 17.6% with environmental studies. Furthermore, 12.2% had less than 10 years of professional experience, 54.5% had between 10 and 15 years of experience, and 28.3% had more than 15 years of experience in executive organizations.

Based on the responses collected from these participants, the conceptual model developed during the qualitative phase was quantitatively evaluated using structural equation modeling (SEM). Table 5 presents the descriptive statistics and Pearson correlation coefficients for the study variables.

Table 5. Descriptive statistics and correlations among research variables (n = 530; **p < 0.01)

Variables	Mean	SD	1	2	3
1. Economic factors	3.74	0.789	1.000		
2. Social factors	3.28	0.952	0.651**	1.000	
3. Environmental factors	3.62	0.724	0.492**	0.574**	1.000

The results presented in Table 5 indicate significant positive correlations among all dimensions of the proposed model ($p < 0.01$).

Before conducting SEM analysis, two statistical criteria were used to evaluate the suitability of the data: The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity. The KMO statistic was found to be 0.820, exceeding the recommended threshold of 0.70 and indicating an adequate sample size for SEM analysis. Moreover, Bartlett's Test of Sphericity was statistically significant ($p < 0.001$), confirming that the correlation matrix was not an identity matrix and sufficient correlations existed among the measurement items to justify structural equation modeling.

Within the PLS-SEM model, model evaluation commenced with an assessment of potential collinearity among predictor constructs, followed by examinations of measurement quality, significance testing, path coefficients, explanatory power, and predictive relevance. The results are summarized in Table 6.

Table 6. Summary statistics of the fitted model (n = 530)

Construct	VIF	AVE	α	CR	RHO	R^2	Adjusted R^2	Q^2	f^2	RMSE	SRMR
Economic factors	3.512	0.674	0.781	0.779	0.782	–	–	–	–	–	–
Social factors	2.744	0.632	0.752	0.750	0.753	–	–	–	–	–	–
Environmental factors	3.639	0.685	0.714	0.718	0.721	–	–	–	–	–	–
Urban sustainable development	–	0.663	0.741	0.735	0.739	0.704	0.701	0.481	0.372	0.054	0.059
Goodness-of-Fit (GoF) = 0.832											

The results demonstrate that all collinearity indices, measurement model criteria, structural model indicators, and overall model fit statistics fall within acceptable ranges. Consequently, the reliability, validity, explanatory power, and predictive capability of the fitted model were confirmed, allowing interpretation of the structural relationships based on path coefficients and significance levels. The summary of the structural model results is presented in Table 7, while the fitted model is illustrated in Figure 3.

Table 7. Structural path coefficients of the fitted model

Predictor construct	Outcome construct	Standardized coefficient (β)	t-value	p-value
Economic factors	Urban sustainable development	0.674**	10.379	0.000
Social factors	Urban sustainable development	0.329**	6.918	0.000
Environmental factors	Urban sustainable development	0.481**	8.996	0.000

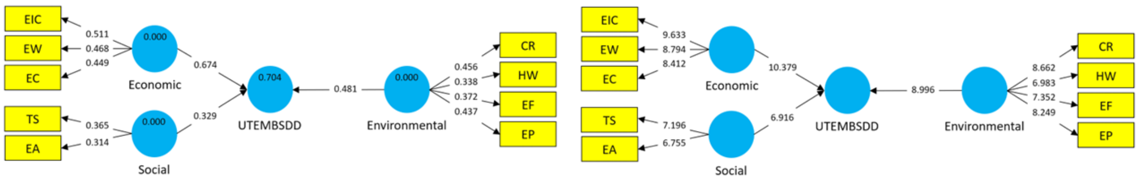

Figure 3. Fitted structural model based on empirical data (standardized path coefficients and significance levels)

The results presented in Table 7 and Figure 3 indicate that all structural paths are statistically significant, with t-values exceeding 1.96 and significance levels below 0.01. Therefore, all direct relationships were confirmed at the 99% confidence level. Among the three dimensions, economic factors exerted the strongest influence on sustainable urban development (β = 0.674), followed by environmental factors (β = 0.481) and social factors (β = 0.329). Within the economic dimension, the most influential components were direct and indirect costs (β = 0.511), economic welfare (β = 0.468), and energy consumption (β = 0.449), respectively. Within the social dimension, travel safety (β = 0.365) exerted a greater influence than equity and accessibility (β = 0.314). Within the environmental dimension, resource consumption (β = 0.456) ranked first, followed by pollutant emission (β = 0.437), environmental compatibility (β = 0.372), and human health and well-being (β = 0.338). The relative weights and rankings of the dimensions and components of the proposed evaluation model are presented in Table 8.

Table 8. Weights and rankings of dimensions and components of the sustainable urban transportation system evaluation model

Dimension	Component	Component weight	Component rank	Dimension weight	Dimension rank
Economic factors	Direct and indirect costs	0.511	1	0.674	1
	Economic welfare	0.468	2		
	Energy consumption	0.449	3		
Social factors	Travel safety	0.365	1	0.329	3
	Equity and accessibility	0.314	2		
Environmental factors	Resource consumption	0.456	1	0.481	2
	Pollutant emission	0.437	2		
	Environmental compatibility	0.372	3		
	Human health and well-being	0.338	4		

The prioritization of the economic dimension in the transportation evaluation model of the Tehran Metropolitan Area is primarily influenced by the political economy of space within this metropolitan region. The dominance of components such as energy consumption and direct costs suggests that, under the pressure of budgetary structures, urban management in Tehran has viewed space as a capital commodity and has organized transportation system evaluation based on financial efficiency (Habibi et al., 2020). This finding is also consistent with the operational realities of Tehran, where a strong dependence on unstable revenue sources has led to the prioritization of projects that offer faster economic returns.

On the other hand, the lowest ranking of the social dimension reflects the predominance of highwayoriented and physical development approaches over people-centered development strategies during recent decades in the Tehran Metropolitan Area. Evidence of this can be observed in the operation of numerous highways and expressways connecting Tehran with its satellite cities, in comparison to the limited rail connection available in the metropolitan region (only one rail line). While the international literature emphasizes equity in accessibility, within the context of this metropolitan area, safety and accessibility equity have often been sacrificed in favor of technical and economic perspectives on transportation (Hosseinzadeh et al., 2023; Ghadami, 2021). This conflict of priorities suggests that the current evaluation system views citizens not as the central objective of development, but rather as elements within the mobility process who should be moved at the lowest possible cost.

Finally, the second-ranking position of the environmental dimension reflects the delayed response of the system to tangible crises such as air pollution and public health concerns in Tehran and its surrounding metropolitan region. Nevertheless, the greater weight assigned to economic considerations indicates that even environmental measures continue to be defined largely in terms of economic justification and reductions in energy consumption.

This ranking demonstrates that vital concepts such as equity in accessibility and travel safety have, in practice, become subordinate to technocratic and physical planning approaches. Within current evaluation models, citizens and the quality of their social experience have been marginalized, while priority has been given to systems that provide greater economic and physical justification (Banister, 2011). This finding is fully consistent with the structural challenges facing Tehran, including the continued dominance of private automobiles over public transportation.

According to the findings presented in Table 8, the "sustainable urban transportation system evaluation model based on sustainable development dimensions" was developed and presented in Figure 4.

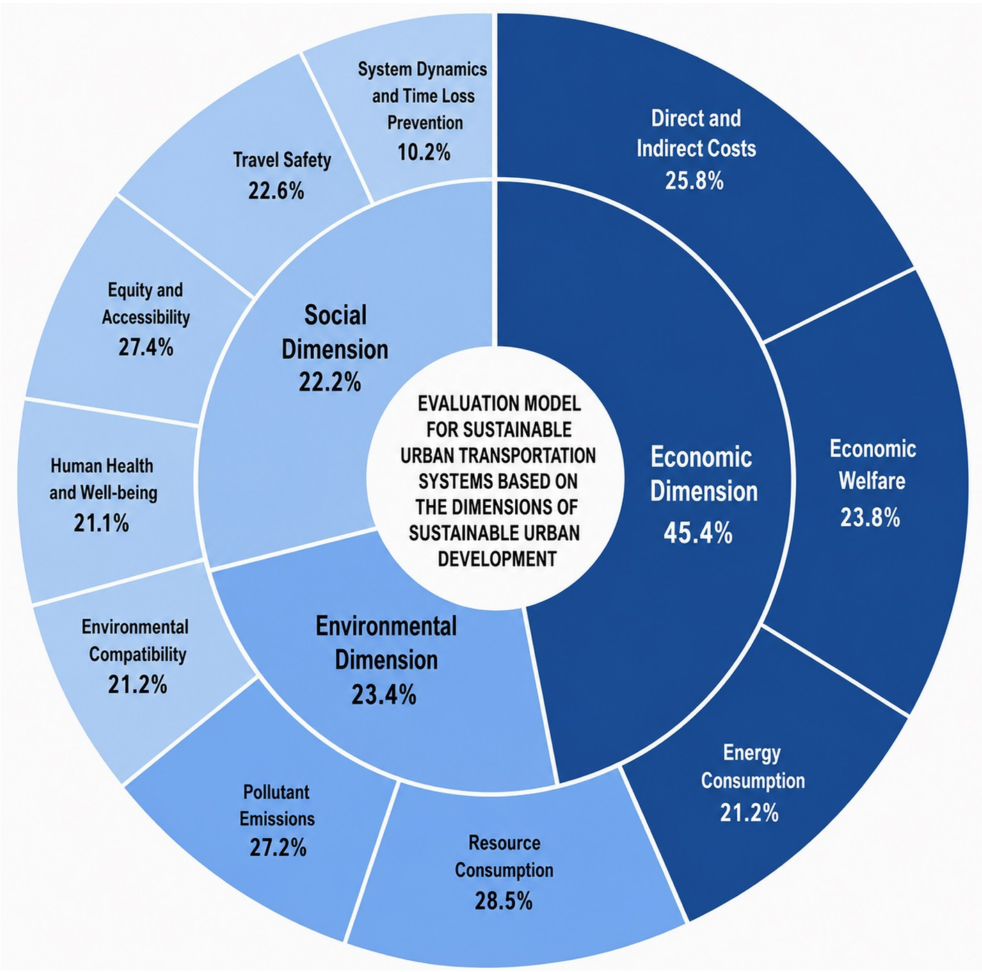

Figure 4. Sustainable urban transportation system evaluation model based on the dimensions of sustainable urban development

5. Discussion and interpretation of findings

The prioritization derived from the present study, in which the economic and environmental dimensions outweigh the social dimension, reflects the structural realities of the Tehran Metropolitan Area. The dominance of economic and environmental considerations suggests that urban management in Tehran has been largely shaped by urgent challenges such as traffic congestion, travel time losses, and excessive fuel consumption (Aghaei, 2023), leading decision-makers toward reactive and capital-intensive strategies. The substantial weights assigned to the components of "Direct and indirect costs" and "Energy consumption" suggest that automobile-oriented development patterns continue to exert a significant influence on transportation evaluation priorities (Norouzi et al., 2023a). Although sustainable development theories emphasize the balanced integration of economic, social, and environmental dimensions (Norouzi et al., 2023b), within the context of Tehran, financial efficiency and environmental mitigation have been prioritized over social considerations such as equity and accessibility due to environmental urgencies and budgetary constraints. This ranking (economic > environmental > social) suggests that sustainability within Tehran's transportation system is primarily governed by resource-crisis management rather than an equity-oriented paradigm.

These findings are consistent with the dominant stream of recent research conducted in developing countries. The alignment of the present results with those of Tiran-Escobar (2024) and Farahmand et al. (2025) confirms that financial pressures and environmental challenges remain the principal bottlenecks in metropolitan transportation evaluation systems. Likewise, the predominance of economic indicators corresponds with the findings of Negussaha (2024), Markarian (2023), and Grand-Ayala (2024), who identified high costs as a major barrier to the adoption of sustainable transportation systems. However, a notable contrast emerges when comparing the present findings with those of Tani et al. (2024), who identified the social dimension as the most influential factor. This discrepancy may be explained by the findings of Barari et al. (2018), who reported a similar prioritization pattern (economic–social–environmental). Such divergence suggests that, despite the theoretical emphasis on human-centered development (Li & Samimi, 2023), transportation evaluation systems in Tehran continue to be influenced by green-economy approaches and environmental imperatives, often placing social equity considerations in a secondary position.

Based on the findings of this study and to operationalize the extracted context-specific evaluation model, the following recommendations are proposed for transportation authorities within the Tehran Metropolitan Area:

1. Transition toward performance-based economic budgeting (priority of the economic dimension)

Given that "Direct and indirect costs" achieved the highest coefficient (0.511) within the model, it is recommended that the Tehran Municipality and related executive agencies move beyond traditional budgeting approaches and adopt sustainability-oriented cost–benefit analysis models. Financial resources should be allocated based on their potential to reduce operational costs and improve energy efficiency, thereby facilitating the replacement of costly and inefficient systems with cleaner and more sustainable infrastructure.

2. Integration of environmental criteria into executive priorities (priority of the environmental dimension)

Considering the second-ranked position of the environmental dimension, sustainability assessment mechanisms should be employed as strategic tools for the optimal allocation of limited resources. Emphasizing indicators related to air pollution reduction and energy efficiency enhancement can provide a realistic pathway toward improving urban quality of life in Tehran while establishing a scientific foundation for short- and medium-term policy interventions.

Furthermore, based on the standardized coefficients obtained from the SEM analysis, several policy recommendations can be advanced. First, within the economic domain, and considering the significant influence of "Economic welfare" ($\beta = 0.468$), urban development policies should gradually shift away from exclusively automobile-oriented projects toward initiatives aimed at minimizing hidden costs. At the same time, public–private partnership (PPP) models should be utilized for fleet modernization programs. Second, within the environmental domain, given the substantial weights of "Resource consumption" ($\beta = 0.456$) and "Pollutant emissions" ($\beta = 0.437$), greater emphasis should be placed on intelligent transportation systems (ITS) and real-time environmental monitoring rather than merely expanding physical transportation infrastructure. Third, within the social domain, despite its lower overall ranking, the importance of "Travel safety” (β = 0.365) necessitates the development of a comprehensive traffic safety action plan by municipal authorities and regional planning agencies. In addition, to promote “Equity and accessibility” (β = 0.314), transportation facilities should be upgraded to accommodate vulnerable groups, and targeted subsidies should be provided to underserved peripheral areas.

Finally, several limitations of the present study should be acknowledged. First, the cross-sectional nature of the research limits the ability to validate empirically causal relationships over time. Second, due to constraints in accessing experts, the initial model development relied on a meta-synthesis approach, which, despite being grounded in credible scholarly sources, may not have fully captured the evolving experiences of current practitioners and decision-makers. Moreover, the use of a self-report questionnaire may have introduced response bias. Therefore, future research is encouraged to test the proposed model in other Iranian Metropolitan Areas with different climatic and socio-spatial characteristics and to employ qualitative approaches, such as in-depth interviews, for more accurate localization of sub-components.

6. Conclusion

The present study was conducted to develop and validate a context-specific model for evaluating sustainable urban transportation systems in the Tehran Metropolitan Area. The findings obtained from the qualitative phase (meta-synthesis) and the quantitative phase (structural equation modeling, SEM) resulted in the development of a comprehensive framework, including three dimensions, nine components, and 53 sub-components. The final results indicated that, within the context of the Tehran Metropolitan Area, the economic and environmental dimensions have higher priority than the social dimension due to managerial urgencies and budgetary constraints. By accurately identifying weaknesses related to resource consumption and direct costs, the proposed context-specific model provides an operational tool for transitioning from traditional management approaches toward intelligent management. Furthermore, through the promotion of cleaner infrastructure and improved accessibility, the model seeks to minimize the gap between “economic necessities” and “social equity” in the sustainable development process of the Tehran Metropolitan Area.

Authors’ Contributions

Mohammad Hossein Norouzi contributed 45% to the study, while Mohammad Javad Kameli, Shahriar Afandizadeh, and Jamshid Salehi Sadaghiani contributed 25%, 15%, and 15%, respectively.

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Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

References

Aghaei M. (2023). Evaluation of urban transportation systems with a sustainable development approach (case study: Districts 1, 2, and 14 of Tehran). In *Proceedings of the 9th International Conference on Modern Studies in Civil Engineering, Architecture, Urban Planning and Environment in the 21st Century, Tehran, Iran*. https://civilica.com/doc/1753132 [in Persian]

Azizian G., Rezvani A. A., & Rajabi A. (2022). Presenting an optimal model for Tehran urban transportation, with emphasis on localized clean energy. *Geography Quarterly (Regional Planning)*, 12(46): 284–312. https://www.doi.org/10.22034/jgeoq.2022.138286 [in Persian]

Banister, D. (2011). The critical role of the social sciences in transport research. *British Academy Review*, 18, 1-10.

Beck, C. T. (2002). A meta-synthesis of qualitative research. *MCN: The American Journal of Maternal/Child Nursing*, 27(4), 214–221. https://doi.org/10.1097/00005721-200207000-00004

Büchel, S., & Marquet, O. (2020). Measuring sustainable urban mobility: A multi-dimensional framework. *Transportation Research Part D: Transport and Environment*, 85, 102487. https://doi.org/10.1016/j.trd.2020.102487

C40 Cities. (2021). The future of urban transportation: Inclusive and climate-resilient mobility. https://www.c40.org

Diao, M. (2019). Towards sustainable urban transport in Singapore: Policy instruments and mobility trends. *Transport Policy*, 81, 320–330. https://doi.org/10.1016/j.tranpol.2018.05.005

Farahmand M., Shokouhiyar S., & Farhabakhsh N. (2025). Ranking sustainable transportation evaluation indicators based on social network analysis (Twitter). *Dynamic Management and Business Analysis*, 4(1): 326–347. https://doi.org/10.61838/dmbaj.2025.30.720 [in Persian]

Gatta, V., Marcucci, E., Nigro, M., & Serafini, S. (2019). Sustainable urban freight transport adopting public transport-based crowdshipping for B2C deliveries. *European Transport Research Review*, 11(1), 1–14. https://doi.org/10.1186/s12544-019-0352-x

Ghadami, M., Alavy Moghadam, M. R., & Esmailpour, A. (2021). Political economy of urban space: Analysis of the drivers of city expansion in Tehran. *Journal of Urban Management*.

Goldman, T., & Gorham, R. (2006). Sustainable urban transport: Four innovative directions. *Technology in Society*, 28(1–2), 261–273. https://doi.org/10.1016/j.techsoc.2005.10.007

Grande-Ayala, C. E. (2024). An assessment of accessibility from a socially sustainable urban mobility approach in mass transit projects. *Sustainability*, 16(9), 3766. https://doi.org/10.3390/su16093766

Habibi, K., Lotfi, S., & Koohsari, M. J. (2020). The political economy of urban land and housing in Tehran: A historical perspective. *Land Use Policy**, 99, 104953. https://doi.org/10.1016/j.landusepol.2020.104953

Heidarpour A., & Jaberi R. (2021). Sustainable transportation in Iran: Measurement and analysis of related indicators. *Urban Economics and Planning Quarterly*, 2(4), 247–264. https://doi.org/10.22034/UE.2022.02.04.01 [in Persian]

Hirai, T., & Comim, F. (2022). Measuring the sustainable development goals: A post analysis. *Ecological Indicators*, 145, 109605. https://doi.org/10.1016/j.ecolind.2022.109605

Hosseini S. J., Rajabi A., Safaeian A., & Rezvani A. A. (2024). Evaluating indicators for achieving public-oriented urban transportation development (case study: District 11 of Tehran). *Urban and Regional Development Planning Quarterly*, 9(28): 197–237. https://doi.org/10.22054/urdp.2023.55092.1248 [in Persian]

Hosseinzadeh, A., Kluger, R., & Moeinaddini, M. (2023). Investigating the barriers to sustainable urban mobility in Middle Eastern megacities: The case of Tehran. *Sustainable Cities and Society**, 92, 104470. https://doi.org/10.1016/j.scs.2023.104470

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Mitigation of climate change*. Cambridge University Press.

International Transport Forum. (2023). *Transport transitions and resilience in cities*. OECD Publishing.

Kline, R. B. (2015). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.

Li, Q., & Samimi, C. (2023). Assessing human mobility and its climatic and socioeconomic factors for sustainable development in Sub-Saharan Africa. *Sustainability*, 15(15), 11661. https://doi.org/10.3390/su151511661

Litman, T. (2023). *Evaluating transportation equity: Guidance for incorporating distributional impacts*. Victoria Transport Policy Institute.

Marcarian, T., Obreja, V., Murray, K., Meltzer, J., & Miller, P. S. (2023). Success in supporting early mobility and exercise in a cardiothoracic intensive care unit. *Journal of Nursing Administration*, 53(3), 161–167. https://doi.org/10.1097/NNA.0000000000001262

Mishra, A. R., Rani, P., Cavallaro, F., Hezam, I. M., & Lakshmi, J. (2023). An integrated intuitionistic fuzzy OCRA method for sustainable urban transportation options selection. *Axioms*, 12(2), 144. https://doi.org/10.3390/axioms12020144

Mohsenin S., & Esfidani M. R. (2017). *Structural equation modeling based on partial least squares using SmartPLS: Applied and instructional*. Mehraban Publishing. [In Persian]

NACTO. (2022). *Equitable micro-mobility: A framework for inclusive planning*. https://nacto.org

Ngossaha, J. M. (2024). Toward sustainable urban mobility: A multidimensional ontology-based framework. *Sustainability*, 16(11), 4458. https://doi.org/10.3390/su16114458

Norouzi M. H., Kameli M. J., Afandizadeh S., & Salehi-Sedghiani J. (2023a). Examining relationships among components of the urban transportation system evaluation model based on sustainable development indicators. *Urban Economics and Planning*, 4(3): 188–210. DOI: 10.22034/UEP.2023.413831.1399 [In Persian]

Norouzi M. H., Kameli M. J., Salehi-Sedghiani J., & Afandizadeh S. (2023b). Explaining the role of energy consumption in the metropolitan transportation evaluation model. *Sustainable Energy Systems Quarterly*, 3(1): 89–112. https://doi.org/10.22059/ses.2024.378320.1077 [In Persian]

Sandelowski, M., & Barroso, J. (2006). *Handbook for synthesizing qualitative research*. Springer Publishing Company.

World Bank. (2023). *Climate-resilient transport infrastructure: A toolkit for cities*. World Bank Publications.