Bagheri F. et al.
June 2027
Urban Economics and Planning
Volume 8, Issue 3

A systematic review of smart transportation indicators in Iranian urban research (2011–2022)

Farhang Bagheri[1*], Soroush Fathi[2]

1. Ph.D. Candidate in Entrepreneurship Management, Qeshm International Education Unit, Science and Research Branch, Islamic Azad University, Tehran, Iran
2. Associate Professor of Sociology, Department of Sociology, WT. C., Islamic Azad University, Tehran, Iran

Review Article

Received: 2026/09/01
Revised: 2026/10/13
Accepted: 2026/10/16

COPYRIGHTS

©2027 The author(s). This is an open access article distributed under the terms of the Creative Commons Attribution (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, as long as the original authors and source are cited. No permission is required from the authors or the publishers.

HOW TO CITE THIS ARTICLE

Bagheri F. Fathi S. A systematic review of smart transportation indicators in Iranian urban research (2011–2022). *Urban Economics and Planning* 8(3):94-117.

DOI: 10.22034/uep.2026.600211.2004

Abstract

Rapid urbanization and the growing complexity of traffic, environmental, and service challenges have increased the need for intelligent transportation in urban management. This study aims to identify, classify, and interpret intelligent transportation indicators in Persian-language studies (1390–1401/2011–2022) and propose a framework. The research is an applied, descriptive–analytical, and PRISMA-based systematic review across four domestic databases (SID, Noormags, Magiran, and Civilica). Of 304 initial records, 61 duplicates and 143 irrelevant articles were removed, 100 entered the general smart-city corpus, and 18 studies were selected for final analysis. Data were extracted with a standardized form and analyzed through deductive–inductive content analysis; study quality was assessed with the MMAT. Findings showed that studies were predominantly descriptive–analytical and single-city, increasing notably in 2021–2022. Based on dual counting of 41 indicators and the studies covering each axis, strategic planning and institutional factors (8 studies), public and sustainable transport (5), and technological infrastructure and intelligent traffic monitoring (3 each) were the most attended axes, whereas non-motorized transport and smart parking, transport equity, resilience, data security, and real-world impact evaluation received less attention. Accordingly, a six-axis framework (infrastructure and technology, intelligent traffic monitoring, public and sustainable transport, non-motorized transport and walkability, smart parking, and strategic planning and institutional factors) was proposed, with components classified by three origins (direct extraction, theoretical synthesis, authors' proposals). The results suggest that measuring intelligent transportation must go beyond a technology-centric approach and encompass functional, social, and environmental indicators.

Keywords

Intelligent transportation systems
smart city
smart mobility
smart transportation
systematic review
urban indicators

* Corresponding Author: farhang.bagheri@gmail.com

1. Introduction

Rapid urban growth and the concentration of population, economic activities, and services in cities have increased the need to revisit approaches to urban management and planning. Although urbanization can drive economic growth, job creation, and improved access to services, poor planning can lead to traffic congestion, air and noise pollution, rising energy consumption, pressure on infrastructure, and a declining quality of life. Hence, contemporary cities require approaches that leverage technology while emphasizing integrated management, citizen participation, economic efficiency, and environmental protection. In this context, the smart city has emerged as a novel approach to urban planning and management.

A smart city is not merely the possession of digital equipment and communication networks; it is a comprehensive approach to enhancing urban performance and citizens' quality of life. In this approach, information and communication technology (ICT), urban data, communication infrastructure, managerial institutions, and human capacities interact to make decision-making, service delivery, and resource management more efficient. In other words, a city is smart when technology resolves real problems, enhances public welfare, strengthens social participation, promotes economic growth, and achieves sustainable development (Nam & Pardo, 2011). Accordingly, the smart city is a multidimensional concept that links physical, social, economic, environmental, managerial, and technological dimensions.

One well-established framework for explaining and assessing the smart city is the model of Giffinger et al. This model examines the smart city across six dimensions: smart economy, smart people, smart governance, smart mobility, smart environment, and smart living. These dimensions are articulated through 31 factors and 74 indicators that explain various urban functions (Giffinger et al., 2007). The framework is significant because it does not reduce the smart city to technology; it also considers human capital, equity, participation, accessibility, sustainability, environmental quality, and transport efficiency. Among these, smart mobility is a fundamental component of the smart city because the movement of people, goods, and information directly relates to many of the city's economic, social, and service activities.

Intelligent transportation refers to the coordinated and optimal use of information, communication, electronic, telecommunication, and control technologies in the transportation system. Its objectives include improving efficiency and safety, reducing travel time and cost, enhancing accessibility, managing travel demand, alleviating traffic congestion, and controlling the environmental impacts of transport. Intelligent transportation systems (ITS) are a set of tools, infrastructures, and processes related to the collection, transmission, processing, and use of transportation data to improve decision-making for managers, operators, and users. Surveillance cameras, positioning systems, variable message signs, intelligent traffic lights, fleet management, electronic payment, smart parking management, travel information services, and routing tools are among the most important applications of this system. In this study, ITS are regarded as the operational technological layer within the broader concept of intelligent transportation, and the two terms are not synonymous. Unlike traditional systems that emphasize road development and capacity expansion, intelligent transportation rests on effective use of information and communication to optimize network performance. In this system, data on vehicle location, traffic volume, weather conditions, incidents, road status, and travel patterns are continuously collected and analyzed. This process enables real-time traffic management, accurate information provision, rapid incident response, reduced waiting time, and increased travel safety (Mangiaracina et al., 2017). Moreover, communication among vehicles and between vehicles and infrastructure reduces human error, improves traffic flow, and enhances the overall performance of the transportation network (Ricardo et al., 2024).

In Giffinger's framework, smart mobility encompasses accessibility, ICT infrastructure, and sustainable and safe transportation systems; this dimension is elaborated in the theoretical background (Giffinger et al., 2007). Nevertheless, recent literature indicates that measuring intelligent transportation should not be confined to technological infrastructures and traffic management systems. The quality and coverage of public transport, active transportation, access for vulnerable groups, spatial and social equity, reductions in energy consumption and emissions, resilience, data security, and user satisfaction must also be considered (Snyder, 2019; Xiao & Watson, 2019). Therefore, intelligent transportation can contribute to smart city and sustainable development goals only when, in

addition to technological efficiency, its social, economic, and environmental impacts are evaluated.

The urban transportation system plays a crucial role in citizens' access to employment, education, health, and services; at the same time, it is a major source of energy consumption, air and noise pollution, and greenhouse gas emissions. Poor performance of this system can increase dependence on private cars, waste time, reduce safety, and increase spatial inequality. In contrast, intelligent transportation, through travel demand management, facilitation of public transport use, improved routing, enhanced safety, and reduced fuel consumption, can help create a healthier and more sustainable city.

Iranian metropolises also face problems such as traffic congestion, the rapid growth of the private car's share in intra-urban trips, inadequate public transport coverage, insufficient pedestrian and cycling infrastructure, air pollution, poor parking management, and network vulnerability to incidents, a reality documented in official air-quality monitoring reports for major cities by the Department of Environment in 2021, Tehran's Comprehensive Traffic Plan reports, and domestic studies of urban transportation (Goudarzi, 2019; Lotfi, 2017). Consequently, the adoption of new technologies and intelligent transportation systems has gained importance; however, their success depends on an accurate understanding of measurable dimensions, components, indicators, and criteria. Implementing technology without regard to a city's social, economic, spatial, and managerial conditions can result in fragmented, costly, and ineffective systems.

A review of domestic studies shows that numerous studies have addressed intelligent transportation directly or indirectly, but most have focused on a specific topic or case. These studies have examined topics such as traffic management, vehicle flow control, smart parking, information provision and routing, vehicular communications, safety, public transport, environment, and civil defense. Despite this topical diversity, the conceptual dispersion and the variation in indicators and measurement methods underscore the need for a systematic review and a coherent framework for evaluating intelligent transportation in Iranian cities.

Accordingly, the main problem of the present study stems from dispersion and heterogeneity in domestic research on intelligent transportation. Despite the growing number of studies, it remains unclear which indicators and criteria studies published between 2011 and 2021 (1390-1401 in the Iranian calendar) have used to measure intelligent transportation, which dimensions have received the most attention, what differences exist in methodological approaches and study scales, and which areas remain neglected. The absence of such an integrated picture limits accurate assessment of the state of knowledge, on the one hand, and paves the way for repeating similar studies and neglecting under-researched topics, on the other. Moreover, the lack of a coherent classification of indicators can obscure the design of measurement instruments, the formulation of urban policies, and the prioritization of transportation investments.

Accordingly, this study systematically reviews domestic smart-city research focusing on the intelligent transportation dimension from 2011 to 2022. The study extracts, classifies, and compares the indicators and criteria used in the reviewed studies and, through the analysis of temporal and thematic trends, provides a coherent picture of domestic research. Furthermore, the methodological approaches and spatial scales of the studies, from the urban to the regional and neighborhood levels, are examined to determine researchers' attention to different levels of analysis. Finally, drawing on the identified indicators and the shortcomings of previous studies, the research proposes a classification and a new model of intelligent transportation topics tailored to the conditions of Iranian cities. The proposed model differs from existing frameworks, including the aggregated smart mobility dimension of Giffinger's model, in that it decomposes indicators into six measurable axes at the urban and neighborhood scales in Iran and measures them at three levels: input, process, and outcome. We elaborated on these distinctions and the study's innovative contribution in the conclusion.

In line with the main objective, the main research question is formulated as follows: how have the indicators and criteria of intelligent transportation in domestic studies of Iranian cities (2011–2022) been identified, classified, and evaluated, and what proposed model for measuring intelligent transportation in Iranian cities can be derived from them? To answer this question, the subsidiary questions are: first, what have been the thematic and temporal trends of research on intelligent transportation in Iranian cities during 2011–2022? Second, with what methodological approaches and at what scales – urban, regional, and neighborhood – have domestic studies examined intelligent transportation? Third, which indicators and criteria of

intelligent transportation have been more prominent in domestic research, and which indicators and areas have received less attention? And fourth, based on the identified indicators, what new, comprehensive classification of intelligent transportation indicators can be proposed for future research and urban policymaking?

2. Theoretical background

The concept of the smart city in the scientific literature results from the intersection of urbanization theories, sustainable development, ICT, and urban governance, and it cannot be reduced merely to the use of digital tools in city administration. Early approaches measure a city's smartness mainly by the development of ICT infrastructure, communication networks, and data-driven systems; newer theories, however, emphasize the role of human capital, managerial institutions, citizen participation, and the social and environmental impacts of technology. From this perspective, the smart city is a socio-technical system in which technology, human agents, institutions, and physical infrastructure interact to enhance the city's capacity for problem-solving and adaptation to change.

Since the three terms "intelligent transportation," "smart mobility," and "intelligent transportation systems (ITS)" recur frequently in the literature and in this article, clarifying their conceptual relationship is essential. In this study, intelligent transportation is the broader, systemic concept that refers to the entire urban mobility chain, including technological infrastructures, transport modes, services, users, and social and environmental impacts. In this relation, ITS is one of the technological and managerial components of intelligent transportation; that is, a specific set of information, communication, electronic, and control technologies (such as cameras, positioning systems, fleet management, and intelligent signal control) employed to improve network performance. In other words, every intelligent transportation system rests on a layer of ITS, but is not confined to it. Smart mobility is a more applied and human-centered concept, introduced in Giffinger's framework as one of the six dimensions of the smart city; it measures the outcome of the interaction between intelligent transportation and users' needs and behaviors, focusing not on technology per se but on the quality, accessibility, sustainability, and experience of citizens' movement. The relationship among the three concepts can thus be formulated as follows: ITS is the technological instrument; intelligent transportation is the system that arises from applying that instrument across the entire mobility chain; and smart mobility is the user-centered outcome and experience of that system within the smart city. Accordingly, this article uses "ITS" when referring to specific technologies and systems, "intelligent transportation" when referring to the overall mobility system, and "smart mobility" when referring to the quality of access and user experience.

One important theoretical framework in this field is Nam and Pardo's conceptual model. They explain the smart city on the basis of three dimensions: technology, people, and institutions. In this view, technology includes hard and soft infrastructure, communication networks, and information systems; people refer to human capital, knowledge, creativity, and citizen participation; and institutions encompass policies, managerial structures, laws, and governance mechanisms (Nam & Pardo, 2011). The importance of this theory for the present study is that intelligent transportation cannot be evaluated merely by counting cameras, traffic control systems, or digital equipment. The efficiency of these systems depends on the alignment among technology, responsible organizations, users, decision-making practices, and the city's social capacities. Therefore, intelligent transportation indicators must include both technological components and institutional and human dimensions.

Chourabi et al. also present an integrative framework that introduces the smart city as a multi-factor phenomenon. In this framework, technology, organization and management, governance, policy, people and communities, economy, built infrastructure, and the natural environment are the main shaping factors of the smart city (Chourabi et al., 2012). Based on this theory, a smart initiative's success does not depend on technology alone; it requires coherence among technological infrastructure, organizational structures, financial resources, cultures of use, public trust, and environmental requirements. This approach is especially important for analyzing intelligent transportation studies, because many studies may focus on a particular technology or application while neglecting issues such as data governance, coordination among transport organizations, access for people with disabilities, and user participation (Lam et al., 2024).

Among the smart city measurement frameworks, Giffinger et al.'s model holds a prominent position. The model rests on six dimensions: smart economy, smart

people, smart governance, smart mobility, smart environment, and smart living (Giffinger et al., 2007). In this framework, smart mobility relates not only to fast vehicle movement but also to appropriate accessibility, ICT infrastructure, sustainable transportation, and travel safety. On this basis, intelligent transportation should be regarded as a mechanism linking the various dimensions of the smart city, since it affects the economy, the environment, quality of life, spatial equity, and social participation. From this model's perspective, evaluating intelligent transportation requires simultaneously examining network performance, infrastructure quality, user access, and the sustainability of transport modes.

Another theoretical foundation of this study is intelligent transportation systems theory. In the transport literature, ITS are defined as a set of information, communication, control, and electronic technologies used to improve the safety, efficiency, reliability, and performance of the transportation system (Deng et al., 2024). This theory rests on three core processes: information, communication, and integration. Information is collected through sensors, cameras, GPS, and other equipment; communication enables data exchange among vehicles, infrastructure, managers, and users; and integration ensures network components operate in a coordinated manner. Consequently, systems such as intelligent signal control, fleet management, travel information, parking management, electronic payment, safety warnings, and emergency response are components of an integrated intelligent transportation system, not isolated technologies (Zhang & Hong, 2024).

On the other hand, sustainable development theory provides an important normative framework for evaluating the impacts of intelligent transportation. According to the Brundtland Report, sustainable development meets the needs of the present generation without compromising the ability of future generations to meet their own needs (Hatami et al., 2025). In transportation, this concept means creating a system that is economically efficient, socially equitable, and environmentally compatible. Therefore, intelligent transportation is on the path to sustainable development when, in addition to reducing travel time and increasing movement speed, it reduces energy consumption and emissions, improves safety, lowers costs, and enhances access for different social groups (Banister, 2008). Banister's "new paradigm for urban mobility" emphasizes that transport problems should not be solved solely by building more roads and expanding car-oriented capacity; they must be accompanied by travel demand management, the strengthening of public transport, the development of walking and cycling, and a reduction in dependence on the private car.

Complementing this view, Hansen's accessibility theory regards accessibility as the product of the interaction among places, activity opportunities, the transport network, and the cost of movement (Kumar, 2020). According to this theory, transport efficiency is measured not only by movement speed or traffic volume but also by people's ability to reach urban opportunities and services. Likewise, the transport justice approach and mobility justice theory emphasize the unequal distribution of mobility opportunities and transport impacts across social groups (Sheller, 2018). From this perspective, indicators such as public transport coverage, access for people with disabilities, spatial equity, travel cost, pedestrian safety, and equal access to smart services must be included in the evaluation of intelligent transportation.

The convergence of these theories indicates that intelligent transportation is a multidimensional, interdisciplinary concept at the intersection of technology, management, sustainability, accessibility, and social justice. Accordingly, this study does not examine intelligent transportation indicators solely based on equipment and technological applications; components such as traffic management, travel information and routing, public transport, safety, the environment, economy and cost, freight transport, emergency conditions, accessibility, and transport justice are also considered. These theoretical foundations provide a framework for extracting and classifying indicators from domestic studies in 2011–2022 and for identifying shortcomings in previous research regarding attention to technology, sustainability, human-centeredness, and the integration of the transportation system.

In summary, each theory plays a specific role in constructing the study's final framework: Giffinger's model is the main framework for classifying indicators and the basis for initial coding. Nam and Pardo's model and Chourabi's framework explain the importance of institutions and people and constitute the foundation of the sixth axis (strategic and institutional factors). The theory of intelligent transportation systems provides the content of the first two axes (technological infrastructure and traffic management). Banister's sustainability paradigm and Hansen's accessibility

theory underpin the public and non-motorized transport axes and the outcome indicators, while mobility justice theory grounds the measurement of access for vulnerable groups. In other words, none of these theories is included merely as a literature review; each supports part of the final six-axis framework, the methodology (coding), and the findings (framework development). Figure 1 shows the relationships among these components – technology, people, institutions, performance, sustainability, accessibility, and justice.

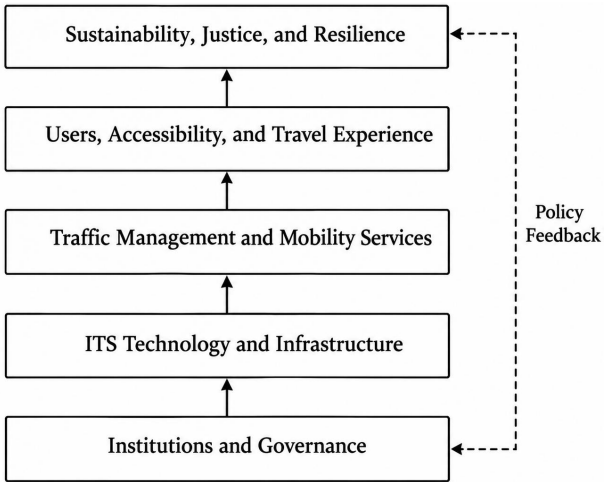


Figure 1. Conceptual framework of the research

3. Research methodology

This study is applied in purpose and descriptive–analytical in nature, using secondary data and the systematic review method. Instead of collecting field data from citizens or urban managers, the study examined scientific articles on smart cities and intelligent transportation and extracted the required information from their content. The study aims to identify, extract, classify, and compare the indicators and criteria domestic studies used to measure intelligent transportation or smart mobility. Since a systematic review, unlike a narrative or conceptual review, rests on a defined search process, predetermined inclusion and exclusion criteria, and transparent screening stages, this study adopted the PRISMA reporting framework, which organizes the stages of identifying sources, removing duplicates, screening titles and abstracts, assessing full texts, and selecting final studies in a regular and reportable manner (Page et al., 2021). In addition, we carried out content analysis of the selected studies to identify the themes, components, indicators, and criteria of intelligent transportation.

The research population comprises scholarly and review articles published in Iran during 2011–2022 (1390–1401, in the Iranian calendar) on smart city, intelligent transportation, smart mobility, smart movement, or a related component. This period was selected to trace the formation and evolution of domestic intelligent transportation research over twelve years; the starting point was 2011 based on prior research, and the endpoint was 2022. Four databases were searched: the Scientific Information Database (SID), Noormags, Magiran, and Civilica, due to their extensive coverage of Persian-language studies in urban planning, urban management, transportation, and information technology. The search employed the keywords “smart city,” “intelligent transportation,” “smart mobility,” “smart movement,” “intelligent transportation systems,” “smart traffic management,” and “smart parking” in the title, abstract, and keyword fields. Synonyms and word-family variants were connected with the OR operator so that articles containing at least one of the phrases were retrieved; this set was then combined with “smart city” using the AND operator to restrict the search to the concurrent presence of the two concepts. Other paired keyword combinations (e.g., “intelligent transportation” and “traffic management”) were also used to increase the comprehensiveness of the search. In databases that did not support combined searches, the phrases were searched individually, and the results were handled at the duplicate-removal stage.

To ensure homogeneity among studies and prevent the inclusion of irrelevant sources, inclusion and exclusion criteria were determined before screening began. Studies were included if they were published between 2011 and 2022, appeared in a scholarly

journal in the country, related to the smart city or intelligent transportation, examined one of the dimensions, components, indicators, or criteria of intelligent transportation, had at least one author specialized in the humanities (studies using purely engineering methods were not synthesized), and had full text available. In addition, the article had to possess a clear research method, an analytical framework, a model, indicators, criteria, strategies, or extractable findings. Studies conducted at the urban, regional, district, or neighborhood scale in Iran were also eligible. We excluded articles published outside the specified period, duplicate records, executive reports, scientific letters, book reviews, non-research notes, and studies whose full text was unavailable. Articles that addressed the smart city only in general terms, without presenting any specific indicator or criterion for transportation, mobility, or movement, were not entered into the final analysis. Articles that merely mentioned the general phrase "six indicators of the smart city" without independently and discernibly examining the intelligent transportation dimension were also excluded, to avoid mixing transportation data with other smart city dimensions, including economy, people, governance, environment, and living.

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Publication between 2011 and 2022	Articles published outside the specified period
Publication in a scholarly, academic, or research journal within the country	Duplicate articles across databases
Topical relevance of the article to the smart city, intelligent transportation, smart mobility, or smart movement	Articles addressing only the smart city in general, without any specific transport, mobility, or movement indicator or criterion
Focus of the article on one of the dimensions, components, indicators, or criteria of intelligent transportation	Executive reports, scientific letters, book reviews, and non-research notes
Availability of the full text	Conference papers, where a scholarly version or credible full text was unavailable
Presence of a clear research method or a framework, model, indicator, criterion, strategy, or extractable finding	Purely theoretical articles lacking empirical evidence, analytical frameworks, or extractable indicators
Relevance of the study to urban, regional, district, or neighborhood scales in Iran	Articles whose full text was unavailable
Expertise of at least one author in the humanities or interdisciplinary studies (suitability of the method to the humanities)	Articles that only mentioned the general phrase "six indicators of the smart city" without independently and discernibly examining the transport or mobility dimension

The identification and selection process proceeded in two stages (Figure 2). In the first stage, we identified the general corpus of studies related to the six main dimensions of the smart city. The initial database search yielded 304 scholarly records. After reviewing bibliographic details, titles, authors, and publication information, we removed 61 duplicates, leaving 243 articles for title-and-abstract screening. We then screened titles and abstracts against the inclusion and exclusion criteria and excluded 143 articles that lacked a direct connection to the smart city, intelligent transportation, or the target indicators. Consequently, 100 articles entered the general smart-city corpus.

In the second stage, we examined the full texts of the 100 articles in detail. We selected articles in which one of the following topics was explicitly examined: intelligent transportation, smart mobility, smart movement, traffic management, public transport, smart parking, vehicle monitoring, non-motorized transport, or ITS. Of the 100 articles, we excluded 82 from the specialized analysis because they lacked a clear focus on intelligent transportation indicators and criteria, and ultimately we selected 18 articles for extraction and final analysis. Thus, the 100-article corpus constitutes the general smart-city corpus, and the 18-article corpus constitutes the final set of studies on intelligent transportation indicators.

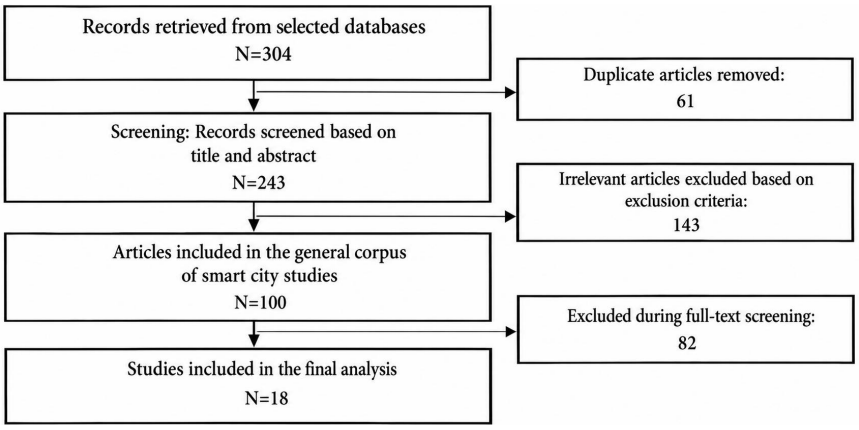


Figure 2. Flow diagram of the identification and screening of studies based on the PRISMA framework

We designed a standardized extraction form with fourteen components (Table 3) and completed uniformly for all selected articles. The coding process was conducted at two levels. At the first level, deductive coding was performed on the basis of Giffinger's smart-city theoretical framework and the classification of intelligent transportation functional domains. At this stage, components such as transport and traffic management, travel information and routing, public transport, vehicles, safety, economy and cost, environment, emergency conditions, freight transport, civil defense, and security were considered initial codes. Ahmadian's classification, which categorizes Iranian intelligent transportation studies into eleven components, was also used in setting the initial codes (Ahmadian, 2022).

At the second level, we performed inductive coding, meaning that each new indicator or criterion identified in the articles that did not fit the initial classification was recorded separately and then placed in the appropriate category based on conceptual and functional similarity. Through this process, components such as active and non-motorized transport, walkability, cycling, transport equity and accessibility, organizational readiness, industry–university collaboration, the Internet of Things, cloud computing, and business intelligence maturity were also considered in the analysis. For example, criteria such as intelligent signal control, traffic monitoring, congestion management, incident management, and flow control were placed in the category of transport and traffic management; likewise, pedestrian walkways, cycling, pedestrian routes, and urban furniture were classified under active and non-motorized transport.

The process of deriving the six-axis framework proceeded in five steps. In the first step, the full texts of all 18 articles were carefully read, and every phrase referring to the measurement, evaluation, or description of intelligent transportation dimensions was recorded sentence-by-sentence in the extraction form. Accordingly, the initial unit of analysis was "the indicator or criterion mentioned in the article," not the article itself. This step yielded 46 initial codes. In the second step, we reviewed and merged the initial codes based on conceptual and functional similarity; indicators referring to the same concept but expressed in different words were grouped into a single composite code. For instance, "intelligent signal control," "congestion management," and "traffic monitoring" were merged into the single code "traffic flow management." This step resulted in 23 concentrated codes. In the third step, we compared the concentrated codes against two references: Giffinger's six-dimensional framework, especially the four factors of the smart mobility dimension, and Ahmadian's eleven-component classification (Ahmadi, 2019). The comparison showed that the codes could not be fully mapped onto Giffinger's four categories, because a group of codes (such as institutional factors, technology acceptance, and industry–university collaboration) belonged to none of Giffinger's four factors, and another group (such as smart parking and non-motorized transport) appeared as scattered subcategories in Ahmadian's classification. In the fourth step, based on this comparison, the final classification criteria were defined inductively: the axes must be independently identifiable without overlap, must have been explicitly and extractably examined in at least one article, must hold an independent functional position in the intelligent transportation system, and must be backed by explicit

evidence in the articles rather than purely theoretical inference. Applying these criteria, we organized the 23 concentrated codes into six final axes, with no code remaining outside them. To develop Table 5, we decomposed the concentrated codes into measurable indicators, resulting in 41 indicators across six axes, as shown in the indicator column of Table 5. In the fifth step, we examined classification validity in two ways. First, content re-examination: one month after the initial coding, we compared the full texts and final codes again, and found no new discrepancies. Second, evidence-base counting: for each axis, we counted the number of articles examined, which formed Table 5.

Screening of titles and abstracts, followed by full-text review, was conducted independently by two researchers, and disagreements were resolved in joint sessions according to the inclusion and exclusion criteria. The same two researchers also extracted and coded indicators independently, and they harmonized discrepant items with the opinion of a third reviewer. Ultimately, the two screeners achieved full agreement on the final version of the criteria.

To clarify the origin of each component, three distinct origins were distinguished in developing the six-axis framework; first, components extracted from the studies, including axes and indicators directly and explicitly present in the text of at least one selected article; second, components of theoretical synthesis, concepts derived from linking the studies' findings with the study's theoretical foundations (Giffinger's model, Nam and Pardo's model, socio-technical systems theory, and Banister's paradigm) that have not been measured independently in any article; and third, components proposed by the authors, suggestions for framework development based on the gap analysis that have not yet been empirically tested. On this basis, the components of the first five axes (technological infrastructure, traffic management, public transport, non-motorized transport, and smart parking) belong to the first group, as 13 articles explicitly examined them. The component of equity and access for vulnerable groups and the social and environmental outcome concepts belong to the second group: although they appear implicitly in two studies (Kaveh, 2021; Kavoosi, 2021), their independent, indicator-based form results from the synthesis with mobility justice theory and Banister's paradigm. The components of network resilience, data security and governance, and the evaluation of the real-world impacts of deployed systems belong to the third group, since none of these concepts has been independently examined in any of the 18 studies; their presence in the framework is a proposal to cover the gaps identified in the review, not a result of direct data extraction.

Regarding the analytical level of the axes, as observed in Table 5, the proposed axes are not homogeneous in nature: some represent topical domains (such as public transport and parking), some managerial functions (such as traffic monitoring and management), and some contextual and governance factors (such as strategic planning and institutional factors). This heterogeneity is deliberate and grounded in the study's theoretical foundations. The proposed framework rests on the socio-technical system model (Nam & Pardo, 2011) and Chourabi et al.'s integrative framework (Chourabi et al., 2012), which regard the smart city not as a list of parallel elements but as a multilayered system comprising "technological inputs," "functions and services," and "the institutional and governance context." Accordingly, the six axes represent different layers of a single system rather than co-equal categories.

Given the differences among the selected articles in purpose, method, scale, statistical population, and variables, the data analysis combined descriptive statistics with systematic content analysis and did not perform statistical meta-analysis. First, the articles' general characteristics – publication year, geographic scope, study scale, and main subject – were examined. Then, the intelligent transportation indicators and criteria were extracted from the article texts and placed into conceptual categories. Next, each indicator's frequency, range of application, and relationship to smart city dimensions were examined. Finally, the most frequent indicators, the least used indicators, and the neglected areas were identified, and the study's proposed classification was presented, combining Giffinger's theoretical framework, Ahmadian's classification, and findings from the selected articles. This classification, in addition to technological and managerial dimensions, includes components such as sustainability, public transport, active transport, accessibility, equity, safety, resilience, and institutional coordination.

During the analysis, the extracted data were checked against the full texts to prevent misinterpretation or recording ambiguous indicators. A distinction was also made between direct intelligent transportation indicators and general smart city indicators; general indicators were entered into the transportation analysis only when the article examined their direct

relationship to intelligent transportation, mobility, accessibility, safety, sustainability, or network performance. In this way, the final analysis focused on indicators with a clear, defensible relationship to the research topic.

Table 2. Summary of the article identification and screening process

Stage	Process description	Count
Initial identification	Articles related to the six smart-city dimensions in scholarly databases	304
Duplicate removal	Removal of duplicate records across databases	61
Title and abstract screening	Assessment of topical relevance to the smart city and intelligent transportation	243
Removal of irrelevant articles	Removal of articles unrelated to the research topic	143
General smart-city corpus	Eligible articles for full-text review	100
Specialized intelligent-transportation screening	Removal of articles lacking specific intelligent-transportation indicators or criteria	82
Final selected studies	Articles entering the detailed analysis	18

Since the studies entering the review are highly heterogeneous in method (from surveys and thematic analysis to modeling and scenario analysis), quality appraisal was performed with the MMAT methodological checklist, designed for the concurrent appraisal of quantitative, qualitative, and mixed-methods studies (Hong et al., 2018). Each study was assessed against five checklist criteria appropriate to its design (fit with the research objective, data collection method, sampling, analysis, and conclusion) and classified into three quality levels: high, moderate, and low. The conversion rule was as follows: for each study, the proportion of confirmed criteria ("yes" responses) out of the five applicable criteria was computed; studies with at least four confirmed criteria (4/5 or 5/5) were rated high quality, those with three (3/5) moderate, and those with two or fewer low. "Cannot tell" responses were conservatively treated as non-confirmation, so that the quality classification would not appear more favorable than the actual evidence. It is emphasized that this appraisal was performed solely to describe the methodological characteristics of the studies and played no role in excluding studies, weighting findings, or prioritizing results in the synthesis; no study was excluded or downgraded based on its quality score, and the appraisal results are reported only as interpretive background to the synthesis. Accordingly, of the 18 selected studies, seven (Farjdi et al.; Bozorgkhoo and Hashemzadeh; Eskandari Sani et al.; Goudarzi et al.; Lotfi et al.; Esmaeilzadeh et al.; Kavoosi and Mohammadi) were rated high quality; six (Kavoosi and Mohammadi; Abbas-Shahir et al.; Shafiei-Nikabadi and Shambyati; Tahmasebi and Ghorbani; Ahmadi et al.; Kaveh et al.) moderate; and five (Nosrati et al.; Pourahmad et al.; Baradaran et al.; Harandi et al.; Parhizgar et al.) low.

A standardized extraction form was designed and completed uniformly for all selected articles, comprising the following sections.

Table 3. Data extraction instrument and form

No.	Component	No.	Component
1	Author(s)	8	Type of study and methodological approach
2	Year of publication	9	Population and sample, where applicable
3	Article title	10	Intelligent transportation indicator or component
4	Journal name and bibliographic details	11	Criteria and sub-indicators used
5	City or geographic scope of the study	12	Technology or system examined
6	Study scale (urban, regional, district, or neighborhood)	13	Key finding of the study
7	Main research objective	14	Position of the article in the final classification

After completing the form, the article data were compared conceptually. When an article examined more than one indicator or component, all identifiable components were recorded in the extraction form; consequently, each article could fall into several thematic categories. For this reason, the total frequency of components does not necessarily equal the number of selected articles.

The following table presents the 18 selected articles. The "initial code" column refers to the article's number in the initial retrieval list, and the "analysis row" column indicates the order of articles in the final research corpus.

Table 4. Characteristics of the selected articles on intelligent transportation

Analysis row	Initial code	Author(s) (Year)	Title	Criterion examined	Method and sample	Key finding
1	1	Farjdi et al. (2020)	Providing essential strategies for launching a camera-based smart parking system	Smart management of public parking	Qualitative research; interviews with 15 academic and executive experts; thematic analysis, SWOT analysis, and prioritization with the QSPM matrix	Identifying initial infrastructure and analyzing strengths/ weaknesses as the two key steps in launching a camera-based smart parking system
2	8	Eskandari Sani et al. (2019)	Assessing the potentials of implementing a smart city with an emphasis on transportation (Birjand)	ITS and traffic management	Applied, descriptive–analytical; data from documentary studies and survey; 383 citizens and 40 experts	Significant relationship between traffic management and citizen satisfaction; necessity of purposeful traffic management centers
3	9	Kavoosi and Mohammadi (2020)	Assessing smart mobility from citizens' perspectives (Shiraz)	Transport infrastructure, public transport, sustainable transport	Descriptive–analytical; documentary and field studies; five-point Likert questionnaire; examination of 11 districts of Shiraz	Spatial inequality in smart mobility across Shiraz districts; some districts in a more favorable condition
4	27	Goudarzi et al. (2019)	Investigating and analyzing the barriers to smartening intra-urban transportation in Ahvaz	Managerial, economic, socio-cultural, and physical barriers	Applied, descriptive–analytical, survey; library studies, observation, and questionnaire; analysis with DEMATEL and ANP	Identification of 65 barriers; managers' weak technical knowledge and funding shortage as the most important barriers
5	49	Pourahmad et al. (2018)	Smart city: explaining the necessities and requirements of Tehran for smartness	Intelligent transportation alongside other smart city dimensions	Explaining the necessities and requirements of Tehran's smartening and presenting executive strategies	Environmental impacts and economic motives, alongside transportation, among the most important requirements of Tehran's smartening
6	53	Kavoosi and Mohammadi (2021)	Smart mobility and social sustainability: an assessment of mutual relationships	Accessibility, sustainable transport, ICT	Descriptive–analytical; documentary and field studies; questionnaire and assessment of citizens' views	Unfavorable status of smart mobility variables in terms of social sustainability in Shiraz
7	58	Esmaeilzadeh et al. (2019)	Analyzing the relationship between smartening and sustainability in urban space (District 6, Tehran)	Public transport as a component of smart living	Correlational method; questionnaire, observation, and interviews; population comprising 18 neighborhoods of District 6, Tehran; reliability via Cronbach's alpha and face validity	Direct relationship between neighborhood smartness level (including access to public transport) and sustainability

Analysis row	Initial code	Author(s) (Year)	Title	Criterion examined	Method and sample	Key finding
8	110	Baradaran et al. (2021)	Scenarios for intelligent control and monitoring of vehicles using the Internet of Things	IoT-based vehicle monitoring and control	Design and implementation of application scenarios; population and sample not reported in the original study	Design and implementation of six scenarios for speed monitoring, traffic-plan and odd-even enforcement, and emergency notification
9	131	Lotfi et al. (2017)	Evaluating the relationship between the smart city and the reduction of public transport problems (Sari)	Public transport	Applied, descriptive–analytical; library and field studies; questionnaire and interviews; sample of 384; Kruskal–Wallis, Friedman, eta correlation, and logistic regression	Significant differences among Sari districts in the possession of smart city and public transport indicators
10	152	Parhizgar et al. (2022)	Analyzing the effects of creating a pedestrian mall in the smart city with a futures studies approach	Use of non-motorized transport, pedestrian routes, and cycling	Applied, descriptive–analytical; indicator extraction via Goller's method; Delphi method with 10 expert questionnaires; cross-impact analysis with MICMAC; identification of 24 factors	Diversity of non-motorized modes, pedestrian and cycling infrastructure, and urban furniture as key factors of smart walkability
11	203	Abbas-Shahir et al. (2022)	Analyzing the development trend of Tabriz with a smart city approach using structural equation modeling	ICT infrastructure and intelligent transportation development alongside other dimensions	Correlational method; questionnaire, observation, and interviews; sample size not reported in the original study	After natural resources, e-government, ICT infrastructure, and intelligent transportation contributed most to Tabriz's growth
12	251	Shafiei-Nikabadi and Shambyati (2021)	Identifying factors affecting IoT acceptance in urban intelligent transportation (Semnan)	IoT technology acceptance in transportation	Survey; instrument and sample not reported in the original study	Experts' views and organizational readiness as the most important factors of IoT acceptance in urban intelligent transportation
13	252	Nosrati et al. (2020)	Designing urban intelligent transportation development scenarios (Hamadan)	Knowledge orientation, integration, and sustainability in intelligent transportation	Not reported in the original study	The knowledge-orientation, integration, and sustainability dimension had the greatest role in shaping Hamadan's intelligent transportation
14	253	Ahmadi et al. (2019)	A combined model for prioritizing smart transportation strategies (Tabriz)	Prioritization of intelligent transportation development strategies	Use of a combined multi-criteria decision-making model	Coordination among government organizations to improve public infrastructure as the most important strategy for Tabriz
15	265	Tahmasebi and Ghorbani (2021)	Identifying barriers to industry–university collaboration in the development of ITS	Industry–university knowledge transfer barriers in ITS	Survey; instrument and sample not reported in the original study	Lack of necessary infrastructure in the ITS industry and the non-applicability of scientific output as the main barriers
16	274	Kaveh et al. (2021)	The role of integrated management in achieving intelligent transportation (case study: Zahedan)	Non-motorized and public/semi-public transport modes	Use of a combined multi-criteria decision-making model	Walking and cycling identified as the leading non-motorized intelligent transportation modes

Analysis row	Initial code	Author(s) (Year)	Title	Criterion examined	Method and sample	Key finding
17	292	Harandi et al. (2020)	The impact of business intelligence maturity on intelligent transportation	Business intelligence maturity and its effect on the intelligent transportation system	Applied, descriptive–analytical; library and field studies; questionnaire and interviews	The examined organizations possess an adequate maturity level for implementing intelligent business systems in transportation
18	293	Bozorgkhoo and Hashemzadeh (2021)	Influential components of cloud computing technology in providing smart services in the rail transportation system	Cloud computing in smart rail services	Qualitative research; interviews with academic and executive experts	Service and infrastructure challenges as the most important issues in applying cloud computing to smart rail transport

4. Findings

The review of the 18 selected articles showed that domestic intelligent transportation studies display considerable methodological, geographic, and thematic diversity; nevertheless, these studies have concentrated more heavily in certain areas, while a clear research gap is observed in several important domains. Regarding research methods, 13 articles used a descriptive–analytical approach. These studies generally assessed the state of intelligent transportation in the studied city or region using documentary studies, field surveys, questionnaires, expert interviews, and indicator analysis. The remaining studies were conducted as surveys, correlational, analytical, futures studies, scenario design, and technology studies. The prevalence of descriptive–analytical methods indicates that a substantial part of domestic research has focused on understanding the current state, assessing cities' possession of intelligent transportation components, and identifying barriers and influential factors. In contrast, studies on the actual performance of systems, the impacts of technology deployment, big data, simulation, before-and-after project evaluation, or real user behavior have a smaller share of the selected corpus.

Geographically, the reviewed studies were conducted in cities and provinces such as Tehran, Tabriz, and Shiraz (two studies each); Ahvaz, Birjand, Semnan, Hamadan, Zahedan, and Sari (one study each); and six studies lacked a defined geographic scope. At first glance, this distribution suggests researchers' attention to different parts of the country; however, closer examination shows that the main focus has been on metropolises, provincial capitals, and cities with greater academic and managerial capacity. Tehran, Shiraz, and Tabriz hold a more prominent position among the selected studies, and a considerable portion of the research is devoted to transportation issues, traffic management, technological infrastructure, and smart development strategies in these cities. In contrast, smaller cities, peripheral cities, and less privileged areas with respect to communication and transportation infrastructure have been studied less. This geographic concentration may cause models proposed by domestic research to align more with metropolises' characteristics, and their generalizability to small and medium-sized cities should be treated with caution.

Regarding the temporal trend, the largest number of selected studies pertains to 2021 and 2022. The increase in publications in the final years of the period indicates that intelligent transportation has gradually become one of the axes of urban planning and sustainable development. This trend may relate to factors such as intensifying traffic problems, the spread of new technologies, and policymakers' attention, although the review data are insufficient to establish causation, and this interpretation is merely a hypothetical, interpretive reading whose testing requires longitudinal trend studies in the future. In terms of methodological quality, according to the MMAT appraisal, seven studies were of high quality, six moderate, and five low; this appraisal was descriptive and played no role in excluding or weighting the studies.

Content analysis of the selected articles showed that the indicators and criteria employed can be classified into six main categories, based on the conceptual similarity of the indicators and their function in the intelligent transportation system. An important point in reading Table 5 is that the counting unit in this study is "the mention or examination of an indicator," not "the number of articles." In other words, each article

was counted in every axis to which it demonstrably and extractably devoted attention, based on the full text's content. Accordingly, Table 5 uses two complementary counting units: the primary unit is the 41 extracted indicators and components, showing the substantive breadth of attention to each axis, and the complementary unit is the number of covering studies, showing how many studies demonstrably addressed that axis. The coverage criterion is the presence of at least one specific, substantiated indicator in the study text, not a mere general mention. In the covering-studies column, an article may simultaneously fall into two or more axes; hence the table's total frequency (22) exceeds the number of selected articles (18). For example, Eskandari Sani et al. (2018) examined traffic management and ITS while also referring to public transport; they are therefore counted in both the second and third axes. The criterion for counting an article in multiple categories is the presence of at least one specific, substantiated indicator or criterion in the text for each category; a mere general or implicit reference was not the criterion for counting. In Table 5, the origin column indicates the extent to which each axis's indicators derive directly from the reviewed studies' texts: components of "direct extraction" have been explicitly examined in at least one selected study; components of "theoretical synthesis," although rooted in the studies' texts, acquired their indicator-based form through linkage with the study's theoretical foundations; and the concepts of network resilience, data security and governance, and the evaluation of real-world impacts are the authors' proposals to cover the identified gaps and, for this reason, are not listed in the table's indicator column, though they are addressed in the methodology.

Table 5. Thematic classification of the reviewed studies and the extracted axes and components

Thematic axis	Indicators and components extracted from the studies	Origin	Covering studies	% of covering studies	Number of indicators	% of indicators
Infrastructure and technology of intelligent transportation	Number and coverage of sensors and cameras; IoT infrastructure and penetration rate; cloud computing and data-processing capacity; ICT infrastructure and communication network coverage; spatial information systems and geodatabases; data infrastructure and inter-system data exchange; interoperability and connectivity of systems; communication systems and telecommunication networks	Direct extraction	3	13.7	8	19.5
Intelligent traffic and vehicle monitoring and management	Coverage and performance of smart traffic management; vehicle and fleet monitoring systems; speed control and calming systems; smart traffic cameras and violation recording rate; management of traffic restriction schemes; smart traffic flow control and system response time; information and emergency warning systems	Direct extraction	3	13.7	7	17.1
Public and sustainable transport	Access to and coverage of the public transport network; service quality and reliability; waiting time and maximum travel time; public transport share of urban trips; sustainable transport and increasing its share; citizen satisfaction with services; linkage of services with social sustainability and pollution reduction	Direct extraction / theoretical synthesis (sustainability outcomes)	5	22.7	7	17.1
Non-motorized transport and walkability	Length and continuity of the pedestrian network; cycling development, capacity, and penetration; design of pedestrian-priority routes; dedicated bicycle routes and network continuity; diversity of transport modes and share of active trips (walking and cycling); urban furniture and pedestrian space quality	Direct extraction / theoretical synthesis (access for people with disabilities)	2	9.1	6	14.6
Smart parking management	Smart parking management systems; automatic camera-based parking violation recording; capacity detection and parking guidance systems; smart entry–exit control	Direct extraction	1	4.5	4	9.8

Thematic axis	Indicators and components extracted from the studies	Origin	Covering studies	% of covering studies	Number of indicators	% of indicators
Strategic planning, scenario-building, and institutional factors	Prioritization of development strategies; use of futures studies and scenario-building; organizational readiness; level of technology acceptance; managerial barriers and managers' technical knowledge deficit; level of institutional coordination; depth of industry–university collaboration; adequacy of financial resources and budgets; integrated management structure and governance mechanisms	Direct extraction/ authors' proposals	8	36.3	9	22.0
Total			22	100	41	100

Comparing the identified categories shows that "strategic planning, scenario-building, and institutional factors," appearing in 8 articles, have been the most broadly attended domain. However, as elaborated in the discussion, the higher frequency of studies on an axis is not by itself a criterion for judging that axis's importance or impact; nevertheless, this finding generally indicates that a substantial portion of domestic studies has examined intelligent transportation from the standpoint of identifying strategies, barriers, requirements, future scenarios, and organizational capacities. In these studies, factors such as coordination among government organizations, organizational readiness, managers' technical knowledge, industry–university collaboration, IoT acceptance, and managerial capacities have played a determining role in realizing intelligent transportation. From this perspective, the smartening of transportation in Iran is not merely a technical issue; it also depends on decision-making structures, institutional coordination, financial resources, knowledge transfer, and organizational capacity.

The category of "public and sustainable transport," with five articles, was the second most attended axis. These studies show that public transport occupies an important place in assessing urban smartness, and factors such as accessibility, service quality, citizen satisfaction, spatial coverage, and the link with social and environmental sustainability are key criteria in this domain. Some studies have also shown that the state of public transport is not uniform across a city's districts, and there are differences among urban areas in access to and possession of smart services. This finding underscores the importance of attending to the spatial distribution of transport services and avoiding average-based assessments, since a city may be in a favorable overall condition while some neighborhoods or social groups receive less benefit from public transport and smart infrastructure.

"Infrastructure and technology of intelligent transportation" and "intelligent traffic and vehicle monitoring and management" each received attention in three articles. In the infrastructure and technology domain, IoT, cloud computing, ICT, and data infrastructures have been introduced as the main underpinnings of intelligent transportation. These studies show that building smart systems without communication infrastructure, data exchange capability, and information processing capacity will have limited effectiveness. In the monitoring and management domain, topics such as traffic control, speed monitoring, vehicle entry–exit control, traffic scheme management, the use of smart cameras, and emergency notification have been considered. Despite their importance, in many studies, the focus has been on introducing the technology or presenting application scenarios, and their real effects on reducing travel time, accidents, fuel consumption, and pollution has rarely been evaluated.

"Non-motorized transport and walkability" has been independently examined in only two articles. These studies emphasize the importance of walking, cycling, designing active routes, creating separate pedestrian and bicycle paths, urban furniture, culture-building, and increasing the diversity of transport modes. This domain in domestic studies is neglected while the recent literature on the smart city and sustainable transport regards active transportation as a pillar of smart mobility. Intelligent transportation should not be confined to cars, traffic control, and digital infrastructure; it must also enable safe, comfortable, and equitable movement for pedestrians, cyclists, the elderly, children, and people with disabilities. Moreover, the relationship between non-motorized transport and spatial and social equity has rarely been independently examined in domestic research.

"Smart parking management" also appears as the main subject in only one article. This indicates that although parking shortages and poor management of parking spaces are significant problems of Iranian metropolises, few studies have evaluated smart parking indicators, capacity management, real-time information provision, electronic reservation, smart pricing, and the link between parking and travel demand management. Hence, smart parking is one of the domains requiring deeper and more applied studies.

Several areas have received less attention in the selected studies. First, transport justice and access for vulnerable groups have been examined in only two studies, and even then implicitly and through adjacent concepts rather than as an independent measurement axis: Kavoosi and Mohammadi (2020) evaluated social sustainability and access to services, and Kaveh et al. (2021) referred to systemic perspectives and justice within the integrated management framework. There is no mention of this area in the other 16 studies. Second, active and non-motorized transport has been independently examined in only two studies (Kaveh, 2021; Parhizgar, 2022) and is absent in the other 16. Third, the resilience of the transportation network to crises, natural disasters, and technological disruptions was not examined in any of the 18 studies. Fourth, security, privacy, and data governance appear in only one study (Baradaran et al., 2021), and even there only marginally and purely technically within IoT scenarios, not as a data governance indicator; this topic is absent in the other 17 studies. Fifth, citizen participation in transportation planning appears in only one study (Kavoosi, 2021), again marginally, as one component of smart mobility. Sixth and finally, the evaluation of the real-world impacts of deployed systems, including before-and-after project evaluation, was not performed in any of the selected studies.

Based on the analysis, the authors' proposed framework for measuring intelligent transportation in Iranian cities comprises six main axes. The first axis is the infrastructure and new technologies of transportation, encompassing IoT, cloud computing, ICT, spatial information systems, sensors, cameras, and data exchange infrastructure. The second axis is intelligent traffic and vehicle monitoring and management, including criteria such as real-time traffic control, incident management, speed monitoring, entry–exit control, travel demand management, and smart information provision. The third axis is intelligent public and semi-public transport, addressing quality, coverage, accessibility, reliability, user satisfaction, fleet management, and the link with social and environmental sustainability. The fourth axis is non-motorized transport and walkability, including walking, cycling, safe and continuous routes, access for people with disabilities, urban furniture, and the link between active transport and health and quality of life. The fifth axis is smart parking, encompassing capacity management, information provision, reservation, electronic payment, entry–exit control, and the link with traffic management. The sixth axis is strategic planning, scenario-building, and institutional factors, including organizational coordination, managerial readiness, financial resources, technology acceptance, industry–university collaboration, budget adequacy, integrated management structure, and governance mechanisms. In addition, the components of network resilience, data security and governance, and evaluation of real-world system impacts have been added to the framework as the authors' proposals to cover the identified gaps (not as components extracted from the studies).

This framework is both descriptive and propositional: the first five axes are largely extracted directly from the content analysis of the reviewed studies; the demographic and social–environmental outcome components result from the theoretical synthesis of the studies with the research's foundations; and the components of network resilience, data security and governance, and the evaluation of real-world impacts are the authors' proposals to cover the gaps identified in the review and have not been independently examined in any of the 18 studies. The full distinction of these three origins is presented in the methodology. The systematic comparison of this framework with Giffinger's model and its three-level measurement logic (input, process, outcome) is elaborated in the discussion and conclusion.

Ultimately, the findings show that domestic intelligent transportation studies, although expanded in number and thematic diversity in recent years, still face conceptual and methodological dispersion. The focus on traffic management, public transport, information technology, and institutional factors has shaped much of the domestic literature; however, active transport, transport justice, resilience, data security, real-world impact evaluation, and user experience measurement have received less attention. Accordingly, the developed six-axis framework can provide a foundation for future studies, provided that, in its application, the

technological axes are measured alongside the functional, social, environmental, and spatial axes.

5. Discussion

The findings of this systematic review show that the literature published in Persian-language databases up to 2022, contrary to the common assumption of the field's technology-centricity, has mostly focused on strategic planning, scenario-building, and institutional factors (eight articles), followed by public and sustainable transport (five articles), technological infrastructure and traffic monitoring (three articles each), non-motorized transport (two articles), and smart parking (one article). These frequencies are reported alongside the count of 41 extracted indicators (Table 5). Moreover, in interpreting Table 5, we must distinguish between two different concepts: "the frequency of studies" and "the importance or impact of a topic." The number of articles on an axis reflects only the degree of domestic researchers' attention to that topic; it does not necessarily mean greater importance, higher priority, or greater impact on the actual performance of the transportation system. For example, the predominance of studies on strategic and institutional factors may stem from three factors unrelated to the intrinsic importance of these factors: first, the relative ease of measuring these factors through interviews and questionnaires compared with hard operational data; second, the availability of organizational experts as the research population compared with field and technological data; and third, the development stage of this field in Iran, in which identifying requirements and barriers precedes the evaluation of deployed systems' performance. Likewise, the scarcity of studies on non-motorized transport or smart parking is not by itself evidence of these domains' lesser importance; rather, as elaborated below, it may reflect a car-oriented perspective, measurement difficulty, or data limitations. Therefore, article frequency in this study is reported as an "index of research attention," not a "criterion of topical importance," and judging each axis's actual importance requires evaluation-oriented studies and the comparison of each component's real effects on transportation outcomes.

Nevertheless, the nature of these institutional and strategic studies suggests that technology may have been researchers' core concern, as they have mostly examined technological barriers, required infrastructures, and technology development strategies, not data governance or social impacts. For instance, Goudarzi et al. (2019) examined funding shortages and technical knowledge; Shafiei-Nikabadi and Shambyati (2021) examined organizational readiness for IoT deployment; Tahmasebi and Ghorbani (2021) examined the non-applicability of scientific output for industry; and Ahmadi et al. (2019) examined the coordination of government organizations as their main subjects; that is, institutions have in all these studies been viewed as instruments facilitating technology deployment, not as subjects of governance and social impacts. In other words, the high frequency of the institutional axis does not mean studies have prioritized social and governance dimensions; rather, from a theoretical standpoint, it reflects an instrumental view of institutions as a precondition for technology deployment. This orientation aligns with Giffinger's classical definition of smart mobility, i.e., the emphasis on accessibility, ICT infrastructure, and modern, safe transportation systems. This focus on ITS components and the IoT, while the more systemic dimensions of intelligent transportation and the user-centered dimension of smart mobility have received less attention, mirrors the same gap between infrastructure smartening and mobility-experience smartening elaborated below (Giffinger et al., 2007). Nevertheless, recent literature measures intelligent transportation not merely by the possession of digital equipment, but also by responsiveness to social needs, reduced inequality, enhanced resilience, environmental protection, and improved travel experience quality (Snyder, 2019; Xiao & Watson, 2019).

The domestic focus on technology and management can be explained through socio-technical systems theory. According to this theory, technology leads to desirable outcomes only when aligned with organizational structures, institutional rules, user behavior, and citizens' needs. Therefore, installing cameras, creating positioning systems, or using the IoT does not by itself guarantee the realization of intelligent transportation; these technologies must lead to better decision-making, improved services, reduced costs, increased safety, and greater citizens' trust. Hence, the technological focus of domestic research is not an absolute weakness, since information infrastructures are preconditions for smartening; the problem arises when these infrastructures are regarded as the end goal rather than a means to achieving social and environmental objectives. Several

factors may have reinforced this pattern: first, to some extent, this field in Iran is still at its initial stage, and studies have naturally begun by identifying necessities and barriers; second, it is plausible that the difficulty of accessing operational data contributed to the prevalence of input and institutional indicators; and third, from a theoretical standpoint, it can be assumed that the tangibility of everyday traffic problems for researchers and policymakers has dimmed attention to concepts such as transport justice (Chourabi et al., 2012). Of course, this judgment is based solely on Persian-language studies, and the possibility of Persian-language studies unpublished in the searched databases, or Iranian studies in international journals not included in this research, must be considered in the interpretation.

The marginalization of social and behavioral dimensions is probably related to the difficulty of measuring them; although none of the 18 studies explicitly stated measurement difficulty as a cause, two indirect pieces of evidence from two articles support this hypothesis: first, the studies that approached these dimensions generally used citizens' questionnaires (Eskandari Sani et al., 2019; Kavoosi, 2021), which indicates that the conventional route for measuring these indicators is costly field surveys; second, the technology studies of Baradaran et al. (2021) and Bozorgkhoo et al. (2021) remained entirely distant from social indicators. This pattern may result from data limitations rather than the researchers' theoretical choices. The present findings also align with Ahmadian's (2022) review of Iranian intelligent transportation studies. The convergence lies in the fact that both identified traffic management, technological systems, and public transport as the main axes; the difference is that the present review was conducted with PRISMA-based screening and a specific focus on indicators, whereas that review was largely topic-oriented, and its eleven-component classification derived from the understanding of topics, not from counting indicator frequencies. Measuring the number of systems or smart equipment is easier than measuring public trust, perceived security, user satisfaction, spatial equity, and the impact of services on underprivileged groups. These axes require granular data, extensive surveys, and spatial analyses, whereas such data are not regularly and accessibly produced in many Iranian cities. The consequence is the potential confusion of "equipping the city with technology" with "realizing smartness."

The pattern identified in this review is also comparable to the evolution of the international literature. In foreign systematic reviews, the shift from technological indicators to outcome- and user-centered indicators is considered the field's stage of maturity (Xiao & Watson, 2019). For example, recent international studies have shifted from counting equipment to measuring smart systems' effects on travel time, safety, and carbon emissions, and justice and access for vulnerable groups have become an independent research topic. Comparing this pattern with domestic studies shows that the Persian-language literature has not yet reached this paradigm shift, a situation equivalent to the initial stage of smart city development in the international literature, i.e., an emphasis on necessities and infrastructures before impact evaluation (Chourabi et al., 2012). Of course, this judgment is based solely on Persian-language studies and should be interpreted cautiously.

One of the study's most important analytical insights is the distance between infrastructure smartening and mobility-experience smartening. Infrastructure smartening concerns creating sensors, cameras, communication networks, and data management systems; but mobility-experience smartening must result in faster, safer, cheaper, more reliable, more equitable, and more sustainable movement of citizens. Accordingly, future evaluations should distinguish among input, process, and outcome levels; the logic of this distinction is elaborated below.

The geographic concentration of studies on metropolises and provincial capitals may also bias the research literature. Although these cities are the natural focus of smartening studies due to population density, traffic complexity, financial resources, and greater academic capacity, problems in small and medium-sized cities are not necessarily similar to those in metropolises. In small cities, poor accessibility, the lack of regular public transport, limited resources, and network vulnerability may matter more than severe traffic congestion. Therefore, intelligent transportation must be context-sensitive, and technology, indicators, and policy priorities must be selected based on each city's demographic, economic, spatial, institutional, and environmental characteristics. The shortage of comparative inter-city studies has also limited the ability to distinguish general indicators from factors dependent on local conditions. Single-city studies are essential for understanding local problems, but they cannot alone determine the generalizability

of solutions. A system may succeed in a city with coherent communication infrastructure and managerial structure, yet fail in another city due to resource shortages or weak institutional coordination. Hence, future research should examine the differences among cities, areas, and social groups through comparative studies.

This dominance can be cautiously interpreted as an indication that intelligent transportation knowledge in Iran is still mostly at the stage of understanding the current situation, identifying obstacles, and developing indicators. These studies are necessary but not sufficient to respond to policy needs. In the next step, longitudinal studies, before-and-after project evaluation, simulation, network analysis, and the use of GPS, fare cards, traffic cameras, and real-time data are required. This approach clarifies the actual effects of smart systems on travel time, speed, accidents, fuel consumption, pollution, and citizen satisfaction. Methodologically, the severe heterogeneity of the studies (in operational definitions, scale, and indicators) precludes statistical meta-analysis and shows that, at the current stage of knowledge, a descriptive–analytical review such as the present one is a more efficient substitute for meta-analysis (Snyder, 2019).

Four studies have specifically examined institutional barriers and capacities: Goudarzi et al. (2019) identified managers' weak technical knowledge and funding shortages as the most important barriers to Ahvaz's smartening; Tahmasebi and Ghorbani (2021) identified the lack of industrial infrastructure and the non-applicability of scientific output as the main barriers to industry–university collaboration; Shafiei-Nikabadi and Shambyati (2021) considered organizational readiness the key factor of IoT acceptance; and Ahmadi et al. (2019) introduced the coordination of government organizations as the most important strategy for Tabriz's intelligent transportation development. On this basis, it can be argued that the fragmentation of systems and the multiplicity of responsible institutions probably reduce technology efficiency, although the direct, empirical effect of these factors on project success or failure has not been tested in the articles and requires causal studies. Therefore, smartening requires – more than equipment procurement –institutional architecture, common standards, clear task division, and sustainable collaboration mechanisms. This finding aligns with Nam and Pardo's view, which regards institutions, alongside technology and people, as one of the main pillars of the smart city (Nam & Pardo, 2011).

From a social justice perspective, intelligent transportation has dual impacts. These services can increase access to travel information and safe routes; however, if the digital divide is ignored, groups lacking adequate access to the internet, smartphones, or electronic payment tools may be deprived of their benefits. Moreover, concentrating projects in privileged areas can exacerbate spatial inequality. Therefore, indicators such as service coverage in underprivileged neighborhoods, access for people with disabilities, travel affordability, digital access, and the satisfaction of vulnerable groups must be included in the evaluations.

The neglect of active transportation may indicate a car-oriented perspective in transportation planning; although this interpretation was not directly extracted from the 18 studies, it is consistent with the studies' indirect evidence: only two studies (Kaveh, 2021; Parhizgar, 2022) have addressed this domain, while in the sustainable transport paradigm, walking and cycling are among the pillars of smart mobility (Banister, 2008). On this basis, pedestrians, cyclists, and other vulnerable users should be regarded, alongside cars and digital infrastructure, as the primary users of the transportation network.

Nevertheless, to strengthen the applicability of the proposed six-axis framework, three measurement levels are proposed. The first is the input level (technology and infrastructure), which refers to the resources and facilities that exist before the system is deployed and are measured by the question "What is available?" such as the number of cameras, the extent of communication network coverage, the number of fleets, or data processing capacity. The distinguishing feature of this level is its countability independent of performance; that is, the axis can be measured without operational data. The mere existence of a system does not indicate its appropriate performance or impact, which is why remaining at this level is insufficient. The second is the process level (performance and management), referring to the quality of the systems' functioning during operation and measured by the question "How well does the system work?" such as processing speed and response time of the system, the accuracy of the data collected, and organizational coordination in operation. The distinguishing feature of this level is its dependence on continuous operational data; we can measure its indicators only while the system is functioning. The third is the outcome level, which refers to the effects and results

of system performance on the city, the environment, and citizens, measured by the question "What change has occurred in reality?" For example, travel time, energy consumption, emissions, accidents, user satisfaction, and travel cost. This level's distinguishing feature is measuring change relative to the pre-deployment state. The logic for assigning each axis is also based on these three questions: each axis belongs to the level whose distinctive question it answers. For example, "camera coverage" answers "What is available?" and is an input; "detection accuracy and warning transmission time" answers the functional question and is a process; and "accident reduction at camera locations" measures real change and is an outcome. For a single technology, axes may be defined at all three levels, and this topical overlap does not negate the level distinction, since the three levels measure different aspects – availability, function, and effect – of the same phenomenon. Finally, regardless of the measurement level, it is proposed that the axes be evaluated at different scales, from the city to the district and neighborhood, so that spatial inequalities and differences among social groups become visible; for a city may be in a favorable overall condition while some neighborhoods or groups receive less benefit from smart services. For example, the IoT should be evaluated in terms of interoperability with other systems, data quality and security, maintenance cost, and impact on decision-making. Public transport, too, should be measured not only by coverage and fleet size, but also by reliability, waiting time, cost, access for people with disabilities, and user satisfaction.

In sum, the discussion showed that the domestic pattern of research attention to intelligent transportation may reflect the development stage, data limitations, and an instrumental view of institutions more than a deliberate theoretical choice; this interpretation is the authors' theoretical inference from the review's frequency pattern, not its direct finding.

6. Conclusion

Through a PRISMA-based systematic review, this study identified, classified, and interpreted the axes of intelligent transportation indicators in Persian-language studies published in domestic databases during 2011–2022.

In answer to the main research question, the results showed that domestic studies have not followed a single standard model for identifying and measuring intelligent transportation; each study analyzed a portion of this concept, according to its purpose, city, and problem. Despite thematic diversity, the studies' main axes have included technological infrastructure, ITS, traffic management, public transport, walkability, smart parking, technology acceptance, institutional barriers, and development strategies. Thus, intelligent transportation is a multidimensional concept in the domestic literature; however, the absence of a shared operational definition makes it difficult to compare research results.

In answer to the first question, attention to intelligent transportation, especially in 2021 and 2022, has increased, and the studies' thematic scope has expanded from necessities and traffic management to new technologies, technology acceptance, and walkability. However, this expansion has not yet culminated in a coherent, standard framework.

In answer to the second question, descriptive–analytical methods (13 of 18 articles) and single-city studies of metropolises and provincial capitals are most prevalent, while longitudinal, data-driven, and evaluation-oriented studies are less common; small and medium-sized cities have been studied less.

In answer to the third question, strategic planning, scenario-building, and institutional factors (eight articles), public and sustainable transport (five articles), and technological infrastructure and intelligent traffic monitoring (three articles each) were the most recurrent research axes; whereas non-motorized transport (two articles), smart parking (one article), transport justice and access for vulnerable groups (implicit examination in two studies), citizen participation and data security (marginal mention in one study each), and network resilience and real-world impact evaluation (entirely unexamined) received less attention. This picture, of course, merely reflects the state of studies published in Persian-language databases up to 2022, and generalizing it to the totality of knowledge produced in this field requires caution. While non-motorized transport and smart parking have been less studied and justice, resilience, data security, and real-world impact evaluation have been almost absent, the findings report detailed statistics on these gaps.

In answer to the fourth question, a six-axis framework, comprising infrastructure and technology, traffic monitoring and management, public and sustainable transport, non-motorized transport, smart parking, and strategic planning and institutional factors, was

proposed, offering a more operational decomposition than the aggregated smart mobility dimension of Giffinger's model. The proposed framework can be compared with Giffinger et al.'s model (2007) on three clear criteria: common dimensions, complementary dimensions, and the logic of adding each dimension. The common dimensions include three of the four factors of the smart mobility dimension in Giffinger's model – local accessibility, access to ICT infrastructure, and the existence of modern and safe transportation systems – which are also preserved in the present framework: accessibility in the third axis (public and sustainable transport), ICT infrastructure in the first axis (infrastructure and new technologies), and safety in the second axis (traffic monitoring and management). This overlap shows that the proposed framework does not eliminate the classical model but rests on the same foundations. The complementary dimensions – three of the six proposed axes – have no specific place in Giffinger's four factors and have been added based on the evidence from the 18 articles: the fifth axis (smart parking management), independently examined in one study and reflecting the tangible problems of Iranian metropolises; the fourth axis (non-motorized transport and walkability), which the sustainable transport literature regards as a pillar of smart mobility (Banister, 2008) but it is not explicitly separated in Giffinger's factors; and the sixth axis (strategic planning, scenario-building, and institutional factors), backed by the four studies on institutional barriers, technology acceptance, and industry–university collaboration, and consistent with the "institutions" pillar of Nam and Pardo's model. The proposed framework is distinct from Giffinger's model in three specific respects. First, Giffinger developed smart mobility as general factors at the level of inter-city comparison in Europe, whereas the present framework is designed to measure at the urban and neighborhood scales in Iran, and each axis's components are decomposed into operable sub-indicators. Second, the present framework measures the topical axes at three levels (input, process, and outcome), a structure absent from Giffinger's model that allows distinguishing "possessing the technology" from "its effectiveness." Third, whereas Giffinger rests on the comparison of European cities, the present framework extracts axes directly from content analysis of Iranian studies and is therefore more consistent with the real problems, barriers, and priorities of Iranian cities. Nevertheless, the present framework does not replace the Giffinger model, and for large-scale international comparisons, the same model retains its application. The proposed framework is, in fact, the "detailed, localized extension" of the smart mobility dimension for measurement at the level of Iranian cities.

In summary, the main innovation of this study is a combination of three components, none of which is found alone in previous domestic studies: based on the search conducted in this research, no PRISMA-based systematic review focused on intelligent transportation indicators in Persian-language studies has yet been reported; and this study, through the dual counting of the extracted indicators (41) and the covering studies of each axis, instead of the customary thematic classifications, has provided a quantitative picture of this literature and developed the six-axis framework as its main scientific output. This framework is presented with the explicit separation of the three origins of components – direct extraction from the studies, theoretical synthesis, and the authors' proposals – so that the boundary between the review's evidence and the research's theoretical contributions remains transparent to the reader. The framework's distinction from Giffinger's model – six-axis decomposition, the addition of evidence-based axes, and three-level measurement – answers the very gaps that the present review revealed. This framework does not replace previous models; rather, it is their detailed, localized extension for measuring intelligent transportation in Iranian cities.

To increase evaluation accuracy, it is further proposed that the framework's indicators be measured at the three levels of input, process, and outcome, so that the mere existence of a smart system is not equated with its real effectiveness; the logic of this distinction is elaborated in the discussion.

The following research suggestions derive directly from the six identified gaps in the findings and the review's methodological limitations.

- Conducting comparative studies among metropolises, medium-sized, and small cities based on the six-axis framework
- Examining the relationship between intelligent transportation and transport justice and access for vulnerable groups
- Developing and testing transportation network resilience indicators against crises and disruptions
- Measuring security, privacy, and data governance as independent indicators
- Conducting before-and-after evaluations of smart projects

- Using spatial data, GPS, fare cards, and real-time data in measuring outcome indicators
- Completing the present review by examining English-language and international studies
- Performing meta-analysis, should future studies achieve methodological homogeneity
- Field validation of the proposed six-axis framework through expert consultation and testing in different cities
- Examining user experience and citizen satisfaction with intelligent transportation services through qualitative approaches
- Studying the effect of smartening on different age and income groups to reveal spatial and social inequalities

The following practical suggestions are based on the barriers and gaps identified in the studies. The suggestions on inter-institutional collaboration and data exchange standards arise from identifying multiple responsible institutions and system fragmentation in four institutional studies (Ahmadi, 2019; Amin-Tahmasebi, 2021; Goudarzi, 2019; Shafiei-Nikabadi, 2021). The suggestion on needs assessment and avoiding fragmented systems arises from the reported barriers of managers' technical knowledge deficits and funding shortages in the Ahvaz study (Goudarzi, 2019). The suggestion of an open data system arises from the absence of regular operational data, elaborated in the discussion as a factor underlying the prevalence of input indicators. Adaptation for vulnerable groups also responds to the absence of an access indicator for these groups in domestic evaluations.

- Balanced development of all six axes, especially active transportation and walkability
- Adapting routes and services for people with disabilities and vulnerable groups
- Strengthening collaboration among the municipality, traffic police, universities, and the private sector, and developing common data exchange standards
- Periodic monitoring of the six-axis indicators and publishing the results, distinguishing input, process, and outcome indicators
- Conducting needs assessment and feasibility studies before project implementation and avoiding fragmented systems
- Developing an open transportation data system with respect for citizens' privacy, to enable the measurement of outcome indicators
- Incorporating intelligent transportation indicators into comprehensive and detailed urban plans, with oversight mechanisms for their implementation
- Holding training programs and capacity-building for urban managers and experts in intelligent transportation technologies

In interpreting this study's findings, it must be noted that the scope of the conclusions is as broad as the scope of the search and the studies entering the research process; hence, the findings describe the state of Persian-language studies published up to 2022, not the totality of existing knowledge on intelligent transportation in Iran. Accordingly, the main limitations of the present study are:

- Restriction of sources to Persian-language articles published in domestic scholarly databases
- Exclusion of studies with purely engineering approaches from the search scope, owing to the fundamental difference between engineering methods and those common in the humanities
- The possibility of missing some studies due to differences in keywords and specialized terminology
- The heterogeneity of the studies in method, statistical population, spatial scale, indicators, and analysis approach
- The impossibility of direct statistical comparison and meta-analysis among the selected studies
- Incomplete bibliographic and methodological information in some articles, including sample size, volume number, and pages
- The non-inclusion of some organizational reports, research plans, and executive experiences not published as articles
- The impossibility of directly generalizing the articles' results to the actual state of all Iranian cities
- The proposed framework's need for field validation and testing in different cities of the country

Authors' Contributions

The first author contributed 50%, and the second author 50%.

Acknowledgments

In preparing this article, we used artificial intelligence, specifically GPT-5.6, to standardize and ensure consistency in references and citations and to review and correct grammatical and linguistic errors. The authors conducted all aspects of the research and developed the scientific content.

Conflict of Interest

The authors of this article declare no conflict of interest.

References

Abbas-Shahir, E. A. (2022). Analysis of the development trend of Tabriz city with a smart city approach using structural equation modeling. *Geography and Regional Planning*, 13(52) 511-526. https://doi.org/10.22034/jgeoq.2022.319754.3466 [In Persian]

Ahmadi T., Fani Z., Rezvaniyan M. T., & Tavakoli-Nia J. (2019). Presenting combination model for prioritizing sustainable development strategies of intelligent transportation system case study: Metropolis of Tabriz. *Geography and Planning*, 23(67): 25-44. https://geoplanning.tabrizu.ac.ir/article_8796_1064.html?lang=fa [In Persian]

Ahmadian, P. (2022). Investigating the Thematic course of smart transportation studies. *Interdisciplinary Studies of Iranian Architecture*, 1(2): 121-146. https://doi.org/10.22133/isia.2023.362066.1024 [In Persian]

Amin-Tahmasebi H., & Qorbani A. (2021). Identifying the barriers to university–industry collaboration in the development of intelligent transportation systems. https://dorl.net/dor/20.1001.1.27170454.1400.10.19.6.7 [In Persian]

Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy*, 15(2), 73-80. https://doi.org/10.1016/j.tranpol.2007.11.008

Baradaran M., Tolouei Ashlaghi A., i Afshar Kazemi, M. A., & Motadel, M. R. (2021). Scenarios for intelligent control and monitoring of vehicles using the internet of things. *Business Intelligence Management Studies*, 9(34), 303-344. https://doi.org/10.22054/IMS.2021.47274.1610 [In Persian]

Bozorgkhoo, N. K., & Hashemzadeh-Kh., G. R. (2021). Influential components of cloud computing technology in providing smart services in transportation systems *Law Enforcement Information and Communications Technology Publications*. https://www.sid.ir/paper/961220/fa [In Persian]

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., Pardo, T. A., & Scholl, H. J. (2012). *2012 45th Hawaii International Conference on System Sciences*, Maui, HI, USA, 2012, 2289-2297. https://doi.org/10.1109/HICSS.2012.615 [In Persian]

Deng, J., Yao, D., Deng, Y., Liu, Z., Yang, J., & Gong, D. (2024). Study on the impact of smart city construction on the health of the elderly population - A quasi-natural experiment in China. *PLoS One*, 19(6), e0305897. https://doi.org/10.1371/journal.pone.0305897

Eskandari Sani M., Moradi M., & Gadei Moghadam P. (2019). Assessing the Potentials of smart cities with an emphasis on urban transportation: A case study of the City of Birjand. *The Journal of Geographical Research on Desert Areas*, 6(2): 159-185. https://doi.org/10.29252/grd.2018.1477 [In Persian]

Esmaeilzadeh H., Fanni Z., & Abdoli S. F. (2019). Making smart: An approach for attaining sustainable urban development (case study: District 6 Tehran). *Human Geography Research*, 51(1): 145-157. https://doi.org/https://doi.org/10.22059/jhgr.2018.254553.1007632 [In Persian]

Faraji S., J., Alikhani M., Jafari Nozar M., & Tabatabaei Mozdabadi S. M. (2020). Provide the necessary strategies for launching intelligent camera-based parking. , *IUESA*. 8 (30) :1-22. https://dor.isc.ac/dor/20.1001.1.23452870.1399.8.30.1.4

Giffinger, R., Fertner, C., Kramar, H., & Meijers, E. (2007). City-ranking of European medium-sized cities. *Cent. Reg. Sci. Vienna UT*, 9(1), 1-12. https://www.smart-cities.com/download/city_ranking_final.pdf

Goudarzi M., Firouzi M. A., & Saeidi O. (2019). Investigating and analyzing the barriers to smartening intra-urban transportation in Ahvaz. *Geography and Urban–Regional Planning*, 9(33): 57-82. https://doi.org/https://doi.org/10.22111/gaij.2019.5085 [In Persian]

Harandi H., Valmohammadi C., Sedqiani S., & Nazafati N. (2020). Business intelligence maturity action on intelligent transportation systems. *Traffic Engineering*. https://dor.isc.ac/dor/20.1001.1.17353459.1399.17.3.15.6 [In Persian]

Hatami, A., Jeloudarlou, S. N., & Asadzadeh, H. (2025). Empowering smart cities: Unlocking citizen participation through AI-driven personalization and perceived value. *Sustainable Futures*, 9, 100664. 10.1016/j.sftr.2025.100664

Hong, Q. N., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., Gagnon, M.-P., Griffiths, F., Nicolau, B., O'Cathain, A., Rousseau, M.-C., Vedel, I., & Pluye, P. (2018). The mixed methods appraisal tool (MMAT) version 2018 for information professionals and researchers. *Education for Information*, 34(4), 285-291. https://doi.org/10.3233/efi-180221

Kaveh A., Bostani M. K., & Miri G. (2021). The role of integrated management in achieving intelligent transportation: A case study of Zahedan City. *Journal of Applied Geography Research*, 24(73): 26-46. https://doi.org/https://doi.org/10.61186/jgs.24.73.26 [In Persian]

Kavoosi E., & Mohammadi J. (2020). Assessment of smart mobility from citizens' perspectives: A case study of Shiraz City. *Journal of Applied Geography Research*, 20(57): 335-353. https://doi.org/ https://doi.org/10.29252/jgs.20.57.335 [In Persian]

Kavoosi E., & Mohammadi J. (2021). Smart mobility and social sustainability: An assessment of mutual relationships. *Journal of Applied Geography Research*, 21(61): 279-294. https://doi.org/https://doi.org/10.52547/jgs.21.61.279 [In Persian]

Kumar, V. (2020). Smart environment for smart cities. *Smart Environment for Smart Cities*, 1-53. https://link.springer.com/book/10.1007/978-981-13-6822-6#page=29

Lam, P. D., Gu, B. H., Lam, H. K., Ok, S. Y., & Lee, S. H. (2024). Digital twin smart city: Integrating IFC and city GML with a semantic graph for advanced 3D city model visualization. *Sensors (Basel)*, 24(12), 3761. https://doi.org/10.3390/s24123761

Lotfi S., Nikpour A., & Mahdavi S. (2017). Evaluating the relationship between smart cities and the reduction of public transportation problems in Sari City. *Geography and Urban–Regional Planning*,, 7(24): 21-38. https://doi.org/https://doi.org/10.22111/gaij.2017.3374 [In Persian]

Mangiaracina, R., Perego, A., Salvadori, G., & Tumino, A. (2017). A comprehensive view of intelligent transport systems for urban smart mobility. *International Journal of Logistics Research and Applications*, 20(1), 39-52. https://doi.org/10.1080/13675567.2016.1241220

Nam, T., & Pardo, T. A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. *Proceedings of the 12th annual international digital government research conference: Digital government innovation in challenging times*. https://doi.org/10.1145/2037556.2037602

Nosrati M., Mehrjoo Z., Zali N., & Naderi N. (2020). Designing urban intelligent transportation development scenarios using

an information–environment analysis approach: A case study of Hamadan City. *Urban and Rural Management*, 59(19): 129-145. https://www.noormags.ir/view/en/articlepage/1694985/ [In Persian]

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., & Brennan, S. E. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews, *bmj*, 372. https://doi.org/10.1136/bmj.n71

Parhizgar S. J. A. (2022). Analyzing the effects of urban highway construction on the city with a futuristic approach. *Iranian Architecture and Urbanism (JIAU)*, 13(2): 421-442. https://doi.org/https://doi.org/10.30475/isau.2021.278400.1673 [In Persian]

Pourahmad A., Ziari K., Hataminejad H. N., & Parsapour Shahabadi S. (2018). Explanation of concept and features of a smart city. *Journal of Baghe Nazer*, 26(79): 155-169. https://doi.org/10.22034/gp.2022.10828 [In Persian]

Ricardo, A. J., Vallejo, M. A., & Aedo, J. E. (2024). Integrating citizen participation in the development of new ICT services for smart cities. *Information*, 15(12), 812. https://doi.org/10.3390/info15120812

Shafiei-Nikabadi, M., & Shambyati, H. (2021). identifying factors affecting IoT acceptance in intelligent urban transportation (case study: Semnan Province). *Urban Economics and Management*, , 9(36), 141-160. http://iueam.ir/article-1-1781-en.html [In Persian]

Sheller, M. (2018). *Mobility justice: The politics of movement in an age of extremes*. Verso Books.

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of business research*, 104, 33-339. 10.1016/j.jbusres.2019.07.039

Xiao, Y.,& Watson, M. (2019). Guidance on conducting a systematic literature review. *Journal of Planning Education and Research*, 39(1), 93-112. https://doi.org/10.1177/0739456X1772397

Zhang, Y., & Hong, W. (2024). A significance of smart city pilot policies in China for enhancing carbon emission efficiency in construction. *Environ Sci Pollut Res Int*, 31(26), 38153-38179. https://doi.org/10.1007/s11356-024-33802-z