Journal of Industrial and Systems Engineering
Vol. 17, No. 1, pp. 233-255
Winter (January) 2025

JISE

Analysis of Sustainable Development in Iran's Free Trade Zones Using a Mixed-Methods Approach and Model Validation

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Abstract

The aim of this study was to analyze sustainable development in Iran's free trade zones using a mixed-methods approach and model validation. In terms of data type, the research employed a mixed approach (qualitative and quantitative), and in terms of purpose, it was developmental. The qualitative part of the study was conducted as a case study, while the quantitative part was designed as a survey. Research participants included managers of free trade zones, university professors specializing in free trade zone studies, experts, and professionals active in these zones. The qualitative sample was purposefully selected and reached theoretical saturation with 14 participants, while the quantitative sample consisted of 385 employees working in the free trade zones. Data analysis in the qualitative phase was performed using thematic analysis, whereas in the quantitative phase, confirmatory factor analysis and structural equation modeling were applied using SmartPLS software. The validity and reliability of the data were confirmed through multiple established methods. Based on the interview analysis, 362 codes were initially extracted during the open coding stage, which were reduced to 246 core codes after removing duplicates. These codes were ultimately categorized into 20 sub-themes and 4 main themes. The findings indicate that sustainable development in Iran's free trade zones

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ISSN: 1735-8272,

requires an integrated and coordinated approach across four dimensions: economic, social, environmental, and institutional.

Keywords: Sustainable development, Free trade zones, Mixed-methods analysis, Iran

1- Introduction

The Free Trade Zones of Iran are designated port and non-port areas that are exempt from certain national regulations. These zones contribute to national development by offering advantages such as tax exemptions, customs duty waivers, the absence of cumbersome foreign exchange and administrative procedures, and the facilitation of export–import processes, thereby attracting foreign investment and enabling technology transfer. Currently, seven Free Trade Zones—Kish, Qeshm, Chabahar, Anzali, Aras, Arvand, and Maku—are active in Iran. However, due to inconsistencies with effective development strategies, their performance has not been successful. One of the approaches that can support development strategies in Iran's Free Trade Zones is the adoption of a sustainable development strategy. Sustainable development can contribute to the growth of these zones across at least three dimensions: economic, social, and environmental. It is an approach to human growth and development that aims to meet present needs without compromising the ability of future generations to meet their own (UN General Assembly, 1987). Its objective is to create a society in which living conditions and the resources required for human well-being are ensured without undermining the integrity of the planet (Mensah, 2019). Sustainable development seeks to establish a balance between economic needs, environmental protection, and social welfare. The 1987 Brundtland Report significantly contributed to shaping the modern understanding of sustainable development.

Sustainable development overlaps with the idea of sustainability, which is a normative concept. UNESCO distinguishes these two notions as follows: "Sustainability is often considered a long-term goal (i.e., a more sustainable world), while sustainable development refers to the many processes and pathways to achieve it" (UNESCO, 2022). The Rio Process, launched at the Earth Summit in 1992 in Rio de Janeiro, brought the concept of sustainable development into international focus. Sustainable development is the foundational principle of the Sustainable Development Goals (SDGs) (Unita et al., 2022). These global goals for 2030 were adopted in 2015 by the UN General Assembly, addressing challenges such as poverty, climate change, biodiversity loss, and peace.

In the Islamic Republic of Iran, Free Trade–Industrial Zones were formally established in the 1990s with the aim of expanding non-oil exports, attracting foreign investment, transferring technology, and creating employment. However, after more than three decades, available evidence shows that not only have many of the intended objectives not been realized, but in some cases, these zones have even produced adverse outcomes regarding sustainable development (Jangi-Zehi et al., 2022).

Numerous comparative and case studies focusing particularly on the Anzali, Aras, and Qeshm zones indicate that these areas have largely become centers for imports rather than hubs for industrial development, technological advancement, and value creation. Policy instability, lack of integrated and transparent governance, weaknesses in digital and physical infrastructure, and misalignment with broader regional development policies are

among the main structural challenges these zones face (Pourdadash & Asghari-Zamani, 2024).

In this context, the concept of "sustainable development," which considers economic, social, and environmental dimensions simultaneously, has become an undeniable necessity for planning in Free Trade Zones. Given environmental pressures, inefficient use of resources, and the need for economic resilience, these zones cannot rely solely on tax exemptions and import facilities; rather, they require an integrated framework to achieve sustainable development—one that effectively links good governance, stable policymaking, private sector participation, and the use of technology and innovation (Pourdadash et al., 2024, Yordanova et al., 2025).

Despite the importance of this issue, a review of existing literature reveals that although scattered studies have examined sustainable development indicators or assessed Free Trade Zone performance, no comprehensive, localized, and effective model has yet been developed for achieving sustainable development in Iran's Free Trade Zones. Such a model must integrate environmental factors (infrastructure, natural ecosystems, geographic location), institutional factors (governance, policymaking, legal structure), and economic and social factors (investment, employment, regional equity) (Kamousi-Alamdari et al., 2021; nozari et al., 2023).

Continuing current trends without structural and policy reforms may lead to consequences such as waste of public resources, increased regional inequality, environmental degradation, declining investor confidence, and ultimately, failure to achieve national sustainable development. Therefore, presenting a comprehensive, realistic, and scientifically grounded model—aligned with global experiences yet tailored to Iran's legal, economic, and social context—is a strategic necessity.

Free Trade Zones can play a significant role in providing special economic facilities such as customs regulations, transportation advantages, tax benefits, utilization of local labor, and the engagement of surrounding regions—all of which can contribute to sustainable development. Achieving this requires a thorough examination of all available capacities, from environmental to human resources, and the effective utilization of these capabilities within the Free Trade Zones. Therefore, the fundamental question is this: How can the Free Trade Zones of the Islamic Republic of Iran achieve sustainable, balanced, and comprehensive development?

2- The Concept of Sustainable Development

Sustainable development refers to meeting the needs of the present generation without compromising the ability of future generations to meet their own needs (WCED, 1987). In contemporary literature, sustainable development encompasses three interrelated dimensions—economic, social, and environmental—which must be managed simultaneously (Sachs, 2019). Within the context of Free Trade Zones, sustainable development implies fostering a dynamic economic environment while preserving resources and maintaining social balance (Zeng, 2021; Aliahmadi et al., 2013).

3- Good Governance Theory and Sustainable Development in Free Trade Zones

Good governance is recognized as one of the fundamental pillars of sustainable development. The United Nations defines good governance based on principles such as transparency, accountability, participation, justice, and the rule of law (UNDP, 2020). In Free Trade Zones, good governance refers to the effective management of regulations, decision-making processes, and policymaking mechanisms, creating a stable and attractive environment for investors (Lee & Chen, 2020). Research indicates that the absence of transparent and coordinated governance reduces investment attraction and leads to inefficiencies in the development of these zones (Wang et al., 2022; Aliahmadi et al., 2016).

4- Regional Development and the Role of Free Trade Zones

Free Trade Zones function as policy instruments for regional development, playing a vital role in attracting investment, facilitating technology transfer, and generating employment (Gholipour & Hassanzadeh, 2020). However, sustainable regional development requires policies grounded in local capacities, efficient infrastructure, and inter-agency coordination (Zhao et al., 2021). Regional development models built on innovation ecosystems and multi-stakeholder partnerships have achieved the most effective outcomes in sustainable development (Feng & Li, 2019).

5- Sustainable Development Models in Free Trade Zones

The literature on sustainable development presents several models designed to guide development in Free Trade Zones. The most prominent include:

- **Participatory Governance Model:**

  This model emphasizes stakeholder engagement, including government, the private sector, civil society, and academia. It enhances transparency, accountability, and resource efficiency (Yin & Ma, 2020).

- **Innovation Ecosystem Model:**

  Highlighting the role of technology, knowledge, and innovation, this model underscores their importance in enhancing productivity and achieving sustainable economic development (Chen et al., 2021). Within this framework, Free Trade Zones must invest in digital infrastructure, technology parks, and research centers.

- **Balanced Development Model:**

  This model focuses on the equitable distribution of opportunities and resources across social groups and geographic regions, preventing socioeconomic inequalities (Zhou et al., 2022).

6- The Importance of Technological and Digital Infrastructure

Information and communication technology (ICT) infrastructure is widely recognized as a driving force of sustainable development. Digital technologies—through improved business processes, cost reduction, and enhanced connectivity—create a more sustainable environment for investment (Li & Lu, 2020). In Free Trade Zones, the adoption of emerging technologies, such as blockchain for transparency and governance, holds particular significance (Khan et al., 2023).

Research Background

This section reviews both domestic and international research related to the topic of the present study. A summary of the reviewed literature is presented concisely in **Table 1**.

Table 1. Research Background

Author(s) & Year	Topic	Method	Findings
Ghaderi et al. (2025)	Narrative analysis of experts' perspectives on the development of the Baneh and Marivan Free Trade–Industrial Zone	Qualitative – Narrative Analysis	The findings indicate core themes including: development of trade relations, development of economic infrastructure, and capital flow under the selective theme of economic/trade opportunities; increased economic dependence, market monopolization, and intensification of financial bubbles under economic/trade threats; strengthening cultural commonalities, regional cohesion, and regional tourism under social/cultural opportunities; and lifestyle influence, changes in ethical–local patterns, and alterations in population structure under social/cultural threats.
Abedi Abesh-Ahmadlou et al. (2023)	Assessing economic development levels in cities within Free Trade Zones using a TOPSIS multi-criteria decision-making model (Case: Aras Free Zone)	Quantitative – Descriptive & Field Study	Results show that Jolfa ranks first in economic development indicators, Hadishahr second, and the Central District and Siah Rud rank third and fourth respectively.
Pourdadash et al. (2023)	Evaluating the role of good governance in achieving sustainable development in the Aras Free Zone	Quantitative – Correlational & Field Study	Pearson correlation and regression results indicate a strong and significant relationship between good governance indicators and sustainable development indicators. Good governance models, with a 62% realization coefficient, can predict and foster sustainable development indicators in the region.
Alidoust-Masuleh et al. (2023)	The role of Free Trade Zones in rural development: challenges and strategies (Case:	Quantitative – SWOT Analysis	Findings indicate that the Anzali Free Trade–Industrial Zone has a favorable geographic position and, due to proximity to Caspian Sea ports, can serve as a tourism hub. Results of the t-test (99% confidence) show that the zone has

	Villages of Anzali Free Zone)		improved employment, income, population stabilization, service delivery, and transportation infrastructure.
Jangi-Zehi et al. (2022)	Evaluating sustainable development in Iran's Free Trade–Industrial Zones	Qualitative – Fuzzy Analysis	Results show that waste separation, collection, transportation, recycling, landfill, and disposal of industrial waste have the strongest internal linkages, while adherence to safety and environmental standards by transportation and tourism companies has the highest external linkage. "Development and support of sustainable development policies" is the most influential internal indicator, while "tourist/customer satisfaction" is the most affected. For external indicators, "community sustainable development education" is most influential and "tourist/customer participation in preventing environmental pollution" is most affected. The study identifies complex interrelationships among indicators and presents causal and relational diagrams.
Kamousi-Alamdari et al. (2021)	Analysis of challenges and strategies for sustainable regional development using a futures-studies approach (Case: Aras Free Zone)	Qualitative – Delphi	Findings show that future challenges are heavily influenced by weak management, lack of clear development programs (absence of modern governance models such as good governance and knowledge-based management), weaknesses in financial–monetary institutions, and legal limitations for industrial development due to land suitability for agriculture. Sustainability evaluation also indicates instability, suggesting the need for strategic planning, forward-looking development, and redefining the zone's national and international role.
Seyed-Alipour & Nazari Khakshour (2019)	The role of Free Trade Zones in sustainable development and social security (Case: Anzali Free Zone)	Quantitative – Descriptive-Analytical & Survey	Findings show that addiction, smuggling, and poverty respectively have the greatest impact on social security in the region.
Dahmardeh Qaleh-No (2019)	Evaluation and prioritization of national Free Trade Zones and their impact on economic development	Qualitative – TOPSIS Analysis	Results show that based on indicators such as exports, imports, domestic and foreign investment, transit, and registered companies, Maku Free Zone ranks first (similarity index 0.919), followed by Arvand, Kish, Anzali, Aras, Qeshm, and Chabahar.
Saremi-Rasouli et al. (2019)	Modeling sustainable industrial development in the Aras Free Zone	Qualitative – Meta-synthesis	After reviewing 64 studies, 44 codes were extracted and categorized into 15 dimensions and 3 components: economic development, social welfare, and environmental protection. The final

			model and causal loops were developed in Vensim. Findings provide a framework for refining managerial mental models and improving industrial development policies.
Nhan, Lu, Kuo, & Nguyen (2025)	Special Economic Zones and Sustainable Development: A study of Chinese provinces	Quantitative – Field Study	Results show that provinces with SEZs transition to greener production faster and have higher social efficiency compared to those without SEZs. Although SEZs promote sustainable development, the findings stress the need to reduce resource overuse, encourage cleaner production, enhance economic benefits for social welfare, and narrow technological gaps in environmental productivity.
Gao et al. (2025)	Sustainability effects of Free Trade Zones: Evidence from water pollution in China	Quantitative – Empirical	The study shows that FTZs significantly reduce local water pollution by 9.17 million tons of untreated wastewater (β = -916.6, $p < 0.01$), and have a spatial spillover effect reducing pollution in neighboring cities by 12.33 million tons (β = -1232.9, $p < 0.01$). Industrial upgrading, technological innovation, and stronger government environmental governance are key mediating channels.
Guan, Wang, & Zhao (2024)	Free Trade Zone policies and green development: An empirical study of Chinese FTZ cities	Quantitative – Field Study	Results show: (a) high-quality FTZ policies and business environments increase total green factor productivity by 8.17%; (b) trade openness and technological innovation have significant mediating effects; (c) impacts are stronger in eastern and central regions and more pronounced in second- and third-phase FTZs; and (d) FTZ establishment positively influences green development in surrounding cities.
Hariram et al. (2023)	Sustainabilism: An integrated socio-economic–environmental model for addressing sustainability	Qualitative – Descriptive Analytical	This study proposes a new socio-economic theory of "sustainabilism," emphasizing quality of life, social justice, culture, global peace, and well-being. Six key principles are outlined, and pathways toward a “sustaining revolution” are proposed. The insights offer valuable directions for further sustainability research.
Wang & Kong (2024)	Impact of Free Trade Zones on corporate sustainability performance: A dual financial–environmental approach	Quantitative – Retrospective	Findings show: (1) FTZ establishment significantly improves financial and environmental performance of firms; (2) FTZs enhance corporate sustainability by reducing transaction costs and increasing innovation; (3) FTZ effects are strongest for competitive industries, non-labor-intensive firms, high-tech enterprises, and large companies.

Liu, Wang, & Cui (2021)	Scenario simulation of FTZ construction impacts on regional sustainable development: Case — Pearl River Delta Urban Agglomeration	Qualitative – Simulation	Results show that FTZ construction significantly boosts import–export trade, economic volume, income, and labor force—all contributing positively to regional sustainable development.

Numerous studies have been conducted on sustainable development and the functions of Free Trade Zones in the Islamic Republic of Iran, most of which have examined the economic, environmental, and social dimensions of these areas. A considerable portion of this research has emphasized the role of Free Trade Zones in economic growth, attracting foreign investment, and increasing employment. However, the treatment of sustainable development has often been superficial and one-dimensional.

From a strengths perspective, some studies—using quantitative methods such as statistical analysis or econometric modeling—have successfully demonstrated the relationship between free zone policies and economic indicators. A number of other studies have attempted to incorporate environmental and social dimensions alongside economic aspects, although these efforts have typically remained at a theoretical level.

Despite these contributions, significant weaknesses are evident in the existing body of literature:

Lack of comprehensiveness: Most studies have addressed sustainable development in a fragmented manner and lack an integrated theoretical framework for the simultaneous analysis of economic, social, and environmental dimensions.

Absence of contextualization: Many of the development models used in previous research are adapted from international sources and therefore insufficiently aligned with Iran's institutional, cultural, and economic conditions.

Neglect of institutional and governance factors: Few studies have examined the role of institutions, policymaking processes, management structures in Free Trade Zones, or the practical challenges involved in achieving sustainable development.

Weakness in field-based and participatory research: Participatory approaches and the inclusion of perspectives from local stakeholders—such as residents, entrepreneurs, and civil society actors—have largely been overlooked, reducing the policy relevance and applicability of research findings.

Accordingly, the main gap in the current literature lies in the absence of a comprehensive, context-specific, and practical model for sustainable development in Iran's Free Trade Zones—one capable of analyzing the interactions among various dimensions of development while accounting for the unique characteristics of each region. This gap underscores the need for new research employing interdisciplinary approaches and emphasizing governance, stakeholder participation, and the localization of sustainable development concepts in order to provide strategic and actionable frameworks for policymakers.

Methodology

This study employed a mixed-methods approach (qualitative and quantitative) in terms of data type and was developmental in purpose. The methodology is explained separately for the qualitative and quantitative phases below:

A. Qualitative Phase

The qualitative part of the study was conducted as a case study using semi-structured interviews. Research participants included managers of free trade zones, managers of private companies within these zones, senior experts with scientific and practical experience, and university professors involved in free trade zone activities. Participants were purposefully selected using a snowball sampling technique, and sampling concluded upon achieving theoretical saturation. After interviewing 10 participants, theoretical saturation was reached, but interviews continued up to 14 participants. According to this technique, sampling continues until new interviews no longer provide novel information and responses become largely repetitive. In this study, interviews 10 through 14 largely reiterated prior responses and did not yield new insights, prompting the researcher to cease further interviews.

To ensure credibility and trustworthiness, data analysis was reviewed and validated by the participants themselves, by peer researchers, and by other experts after initial analysis. Additionally, reexamination and verification were conducted by both the primary researcher and a co-researcher to ensure data reliability.

B. Quantitative Phase

The quantitative part of the study was applied in purpose and descriptive-survey in design. The target population included all employees working in free trade zones across Iran. Given the large and essentially unlimited population, a sample of 385 respondents was determined based on the Morgan and Krejcie table. Over 500 questionnaires were distributed to ensure sufficient responses, and ultimately 385 completed questionnaires were received and analyzed.

Questionnaire validity was established through expert review for content validity and factor analysis for construct validity. Reliability was assessed using Cronbach's alpha, and since the alpha coefficient for each item exceeded 0.70, the instrument was considered reliable. Data analysis for the quantitative phase was conducted using SmartPLS software.

Findings

The research findings are presented and analyzed in two sections: qualitative and quantitative.

A. Qualitative Section:

After reviewing the relevant literature, an interview protocol was developed. Experts who agreed to participate were then identified and interviewed. Upon reaching theoretical saturation, the recorded audio files were transcribed, and key statements were extracted from the interview documents.

The main steps of thematic network analysis involved text decomposition, exploration, and integration of findings, which are described in detail below:

1. **Text Preparation:**
   First, recorded interviews were transcribed and complemented with notes taken during the interview sessions. During this stage, 380 concepts were identified

through open coding. After removing duplicates, this number was reduced to 246 primary codes.

2. **Theme Formation:**
   After establishing the primary codes, organizing themes and global themes were abstracted based on these primary codes. In this stage, 20 sub-themes were identified.
3. **Theme Network Discovery and Description:**
   In this step, based on the sub-themes, 4 main overarching themes were identified.

Table 2. Identification of Primary, Sub, and Main Themes

Main Themes	Sub-Themes	Basic Themes
Economic Dimension	Investment and Regional Economy	• Attracting foreign investment• Tax incentives• Regional GDP growth• Per capita income• Regional financial health• Rapid export settlement• Small-scale investment• Investment risk• Ensuring financial security• Venture capital• Angel investors
	International Market and Trade	• Export product diversity• Regional competitiveness• Reducing trade costs• Access to global markets• International advertising media• Regional branding• Service exports• Free trade agreements• Secure trade
	Infrastructure and Logistics	• Logistical infrastructure• Transportation development• Railway development• Port development• Smart customs system• Efficient customs management• Reverse logistics• Industrial water supply• Stable electricity• Sustainable water supply
	Technology and Innovation	• Technological innovation• Technology transfer• Science and technology parks• Startup ecosystem development• Knowledge-based companies• Startup ecosystem• Clean technology• Green technology• Robotics development• Artificial intelligence• Production line automation• Blockchain technology• Innovation center• Technology accelerator
	Business Support and Entrepreneurship	• SME support• Entrepreneurship growth• Market linkage• Joint investment• Public–private partnership (PPP)
	Industrial Development and Specialized Clusters	• Industrial cluster creation• Industrial town• Specialized cluster• International standards• ISO system• Quality control
	Finance and Banking	• Banking ecosystem• Special banking facilities• Financial credit mechanism• Insurability

	Economic and Environmental Sustainability	• Circular economy• Waste reduction• Resource reuse• Resource sharing• Sustainable supply chain development
Social Dimension	Education and Skills Development	• Attracting skilled workforce• Digital skills training• Technical and vocational training• Educational equity• Entrepreneurship education
	Equity and Human Development	• Educational equity• Gender equity• Poverty reduction• Access to adequate housing• Youth employment• Preventing migration• Welfare index
	Security and Health	• Cybersecurity• Data protection• Public health• Healthcare services• Insurance coverage• Regional health insurance• Social security• Crime reduction
	Culture and Society	• Local culture development• Enhancing social vitality• Women's participation• Gender equity• Women empowerment• Public participation• Cultural festivals• International events• Collaboration with artists• Public spaces• Parks and recreation
	Stakeholder and Participation Management	• Stakeholder satisfaction• Stakeholder feedback• Stakeholder analysis• Public participation• NGO support
Environmental Dimension	Environment and Sustainable Development	• Air pollution control• Wastewater control• Environmental monitoring system• Urban and industrial waste management• Recycling• Renewable energy• Solar and wind power plants• Energy efficiency• Clean transportation (metro, electric buses, cycling)• Urban green space and green belt• Biodiversity protection• Environmental impact assessment (EIA)• Sustainability reporting• ESG indicators• Climate adaptation• Urban regeneration• Flood and drought resilience• Green architecture and low-energy buildings
	Risk and Crisis Management	• Risk management• Risk analysis• Insurability• Natural disaster management• Resilience to natural hazards
Governance and Institutional Dimension	Government Management and Governance	• E-government• Bureaucracy reduction• License acceleration• Managerial transparency• Anti-corruption• Accountability• Rule of law• Regional governance• Public participation• Participatory management• Regional council
	Smart City and Digital Technology	• Digital infrastructure• High-speed internet• Open data• Financial and data transparency• Smart building systems• Traffic control systems• Transparent government• Regional database
	Diplomacy and International Cooperation	• University collaboration• International cooperation• Relations with China• Relations with the EU• Relations with neighboring countries• Economic diplomacy• Urban diplomacy

	Knowledge Management and Research	• Research and development• Knowledge management• Organizational learning• Experience transfer• SWOT and PESTEL analysis
	Intellectual Property Rights and Legal Protection	• Intellectual property protection• Patents• Copyright• Legal reform• Enforcement guarantees

The results of the thematic analysis indicate that the sustainable development model in Iran's free trade zones is founded on four main dimensions: economic, social, environmental, and governance.

B: Quantitative Section:

Based on the analysis of the demographic data collected through the questionnaire, out of a total of 385 respondents, 254 individuals (66%) were male and 131 individuals (34%) were female, indicating a male predominance in the studied sample. Regarding age distribution, the majority of respondents were in the 31–35 years (23.6%) and 36–40 years (22.3%) age groups, while the smallest groups were those under 30 and over 45 years, each comprising approximately 21% of the sample.

An analysis of educational levels shows that most participants held a bachelor's degree (45.2%) or a master's degree (26.8%), with only 2.6% holding a doctoral degree, indicating a relatively high educational level among the sample. In terms of work experience, the largest groups had between 6–10 years (22.6%) and more than 20 years (21.3%) of experience, reflecting a mix of relatively new and highly experienced professionals in the study sample. Collectively, these data demonstrate adequate diversity in demographic variables and provide an overall view of the characteristics of the research population.

For the inferential analysis and to ensure the validity of the questionnaire, it was first necessary to determine whether the sample size was sufficient for factor analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was employed for this purpose. The KMO value was found to be 0.888. Given that the Bartlett's test of sphericity was significant at $p < 0.05$, the sample was deemed adequate for factor analysis

Table 2. Assessment of Sample Adequacy

Measure	Value
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	0.888
Bartlett's Test of Sphericity	
– Chi-Square	10039.869
– Degrees of Freedom	903
– Significance (Sig.)	0.000

In this section, the relationships between the variables are examined. For this purpose, a second-order confirmatory factor analysis (CFA) was conducted using the SmartPLS software.

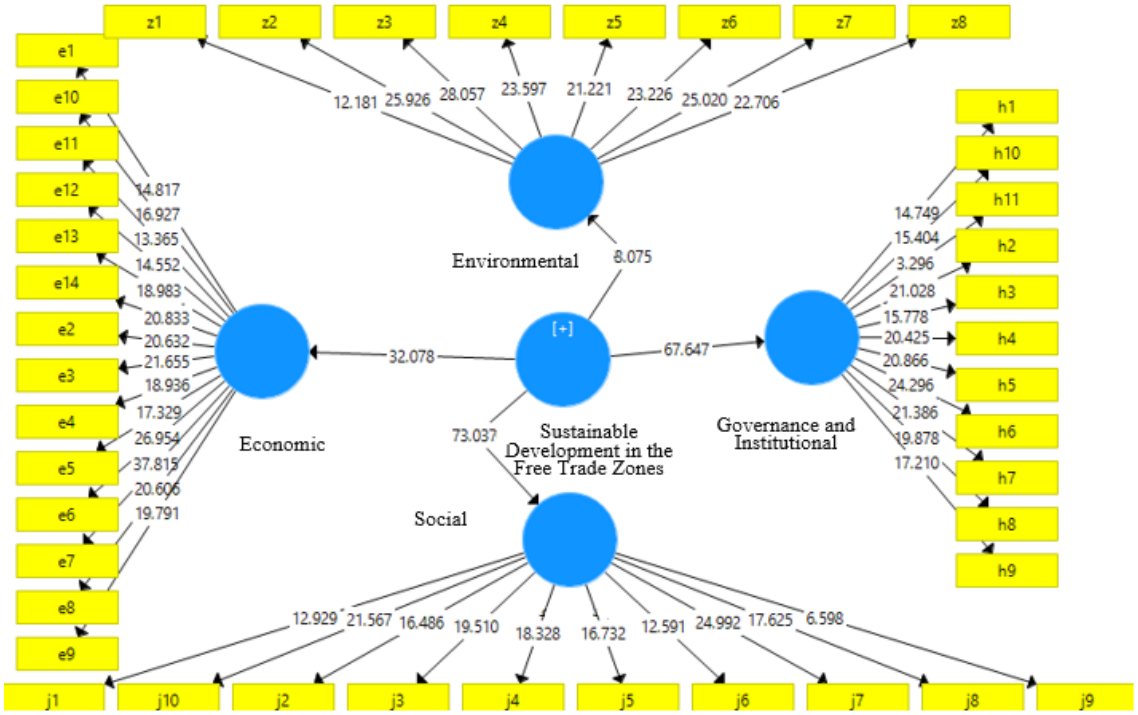

Figure 1. t-values for the relationships between research variables in the structural model at a significance level (t-value)

As observed in Figures 1 and 2, the overall validity of the indicators and items is confirmed. According to the information in Figure 1-4, the t-values for the sustainable development indicators in free trade zones exceed their critical value at the 5% significance level (1.96), confirming the validity of the indicators and items. The standardized coefficients of the variables are also presented in Figure 2.

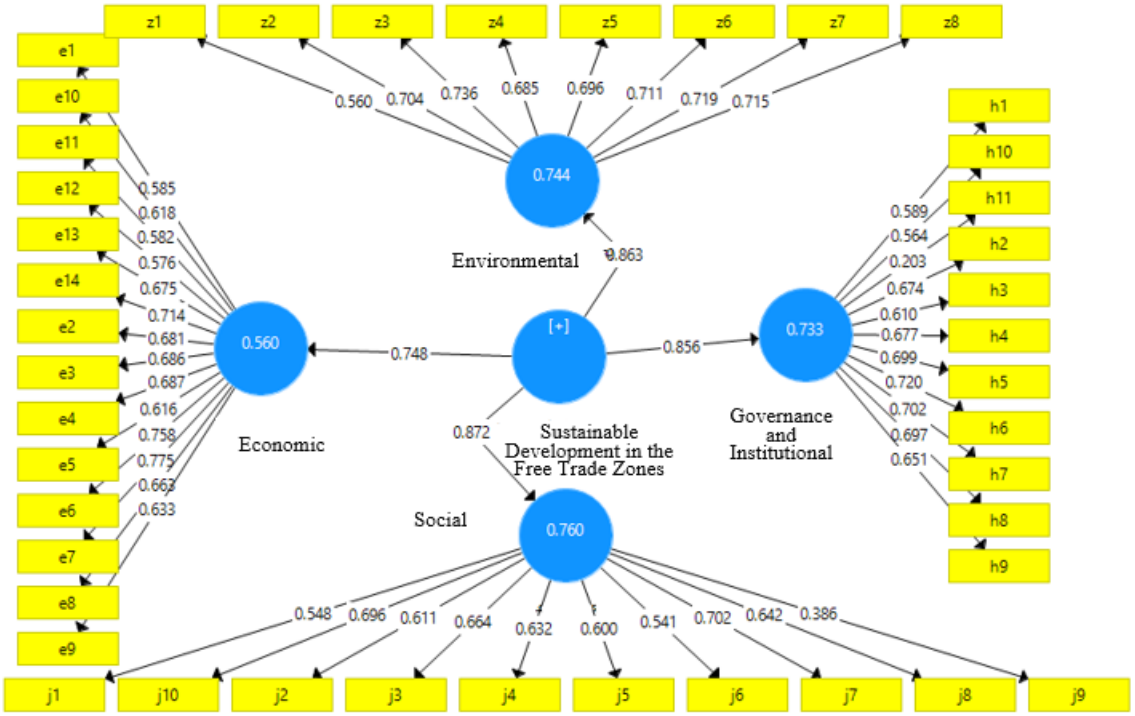

Figure 2. Assessment of the effects of research variables using the structural model in terms of standardized coefficients

Table 2 presents the results of the first- and second-order factor analysis, indicating the validation of the indicators and the relationships of some paths

Table 3. Assessment of Path Coefficient Effects

Indicator	Path Coefficient	Standard Error	t-value	P Value	Result
e1 <- Economic Dimension	0.585	0.039	14.817	0.000	Confirmed
e10 <- Economic Dimension	0.618	0.036	16.927	0.000	Confirmed
e11 <- Economic Dimension	0.582	0.044	13.365	0.000	Confirmed
e12 <- Economic Dimension	0.576	0.040	14.552	0.000	Confirmed
e13 <- Economic Dimension	0.675	0.036	18.983	0.000	Confirmed
e14 <- Economic Dimension	0.714	0.034	20.833	0.000	Confirmed
e2 <- Economic Dimension	0.681	0.033	20.632	0.000	Confirmed
e3 <- Economic Dimension	0.686	0.032	21.655	0.000	Confirmed
e4 <- Economic Dimension	0.687	0.036	18.936	0.000	Confirmed
e5 <- Economic Dimension	0.616	0.036	17.329	0.000	Confirmed
e6 <- Economic Dimension	0.758	0.028	26.954	0.000	Confirmed
e7 <- Economic Dimension	0.775	0.020	37.815	0.000	Confirmed
e8 <- Economic Dimension	0.663	0.032	20.606	0.000	Confirmed
e9 <- Economic Dimension	0.633	0.032	19.791	0.000	Confirmed
h1 <- Governance and Institutional Dimension	0.589	0.040	14.749	0.000	Confirmed
h10 <- Governance and Institutional Dimension	0.564	0.037	15.404	0.000	Confirmed

h11 <- Governance and Institutional Dimension	0.203	0.062	3.296	0.001	Confirmed
h2 <- Governance and Institutional Dimension	0.674	0.032	21.028	0.000	Confirmed
h3 <- Governance and Institutional Dimension	0.610	0.039	15.778	0.000	Confirmed
h4 <- Governance and Institutional Dimension	0.677	0.033	20.425	0.000	Confirmed
h5 <- Governance and Institutional Dimension	0.699	0.033	20.866	0.000	Confirmed
h6 <- Governance and Institutional Dimension	0.720	0.030	24.296	0.000	Confirmed
h7 <- Governance and Institutional Dimension	0.702	0.033	21.386	0.000	Confirmed
h8 <- Governance and Institutional Dimension	0.697	0.035	19.878	0.000	Confirmed
h9 <- Governance and Institutional Dimension	0.651	0.038	17.210	0.000	Confirmed
j1 <- Social Dimension	0.548	0.042	12.929	0.000	Confirmed
j10 <- Social Dimension	0.696	0.032	21.567	0.000	Confirmed
j2 <- Social Dimension	0.611	0.037	16.486	0.000	Confirmed
j3 <- Social Dimension	0.664	0.034	19.510	0.000	Confirmed
j4 <- Social Dimension	0.632	0.035	18.328	0.000	Confirmed
j5 <- Social Dimension	0.600	0.036	16.732	0.000	Confirmed
j6 <- Social Dimension	0.541	0.043	12.591	0.000	Confirmed
j7 <- Social Dimension	0.702	0.028	24.992	0.000	Confirmed
j8 <- Social Dimension	0.642	0.036	17.625	0.000	Confirmed
j9 <- Social Dimension	0.386	0.058	6.598	0.000	Confirmed
z1 <- Environmental Dimension	0.560	0.046	12.181	0.000	Confirmed
z2 <- Environmental Dimension	0.704	0.027	25.926	0.000	Confirmed
z3 <- Environmental Dimension	0.736	0.026	28.057	0.000	Confirmed
z4 <- Environmental Dimension	0.685	0.029	23.597	0.000	Confirmed
z5 <- Environmental Dimension	0.696	0.033	21.221	0.000	Confirmed
z6 <- Environmental Dimension	0.711	0.031	23.226	0.000	Confirmed
z7 <- Environmental Dimension	0.719	0.029	25.020	0.000	Confirmed
z8 <- Environmental Dimension	0.715	0.031	22.706	0.000	Confirmed

As mentioned in the previous section, the factor loadings (path coefficients) of all indicators were confirmed. This is because the t-values of all indicators exceeded the critical value of 1.96 at the 95% confidence level.

Table 4. Assessment of Component Validity

Path	Impact Coefficient	Standard Deviation	t-value	P Value	Result
Free Zones Sustainable Development -> Social Dimension	0.872	0.012	73.037	0.000	Confirmed
Free Zones Sustainable Development -> Economic Dimension	0.748	0.023	32.078	0.000	Confirmed
Free Zones Sustainable Development -> Governance & Institutional Dimension	0.856	0.013	67.647	0.000	Confirmed

Free Zones Sustainable Development -> Environmental Dimension	0.863	0.014	63.075	0.000	Confirmed

As shown in Table 4, it can be concluded that the relationships between variables are confirmed, and the research model is validated.

Overall Model Fit:

Table 5. Overall Model Fit

Variables	R^2	Shared Variance (Communality)
Social Dimension	0.760	0.273
Economic Dimension	0.560	0.227
Governance & Institutional Dimension	0.733	0.283
Environmental Dimension	0.744	0.353
Mean	0.699	0.284
GOF	0.445	

As observed in the table above, the Goodness of Fit (GOF) index is 0.445, indicating a strong and satisfactory fit for the model.

Table 6. Results of Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE)

Variables	Cronbach's Alpha (α>0.7)	Composite Reliability (CR>0.7)	Average Variance Extracted (AVE>0.4)	Result
Social Dimension	0.807	0.852	0.580	Confirmed
Economic Dimension	0.902	0.916	0.621	Confirmed
Governance & Institutional Dimension	0.838	0.875	0.546	Confirmed
Environmental Dimension	0.844	0.880	0.560	Confirmed

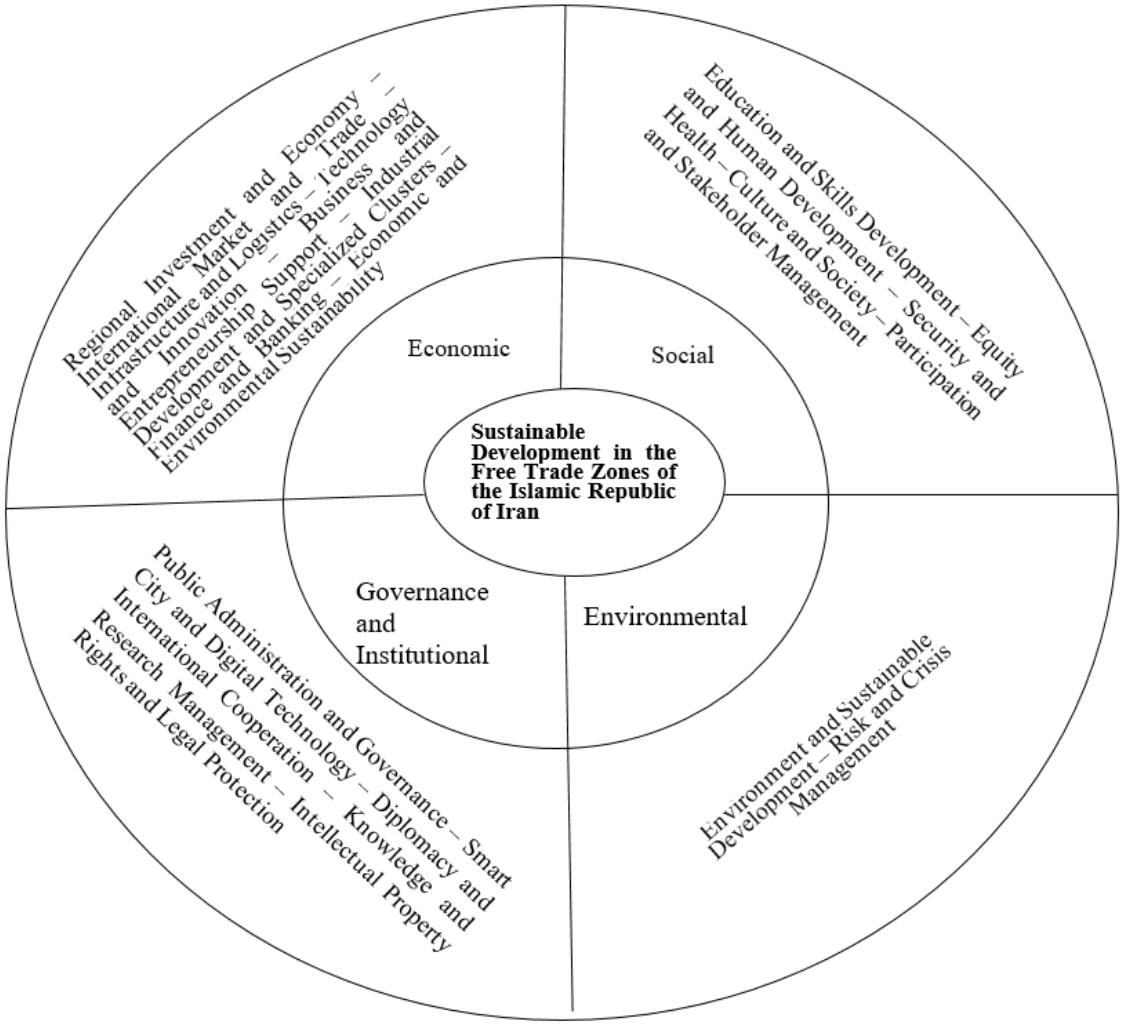

Figure 3. Final Research Model

The results of the study indicate that the sustainable development model in Iran's free trade zones rests on four main dimensions: economic, social, environmental, and governance. Each of these dimensions includes a set of key components and indicators.

- **Economic dimension:** focuses on attracting investment, enhancing infrastructure, developing international trade, promoting innovation and technology, supporting businesses, and establishing industrial clusters.
- **Social dimension:** emphasizes skill development, social justice and welfare, security and public health, cultural promotion and social participation, and stakeholder management.
- **Environmental dimension:** stresses pollution control, resource management, renewable energy, clean transportation, and increasing environmental resilience.

- **Governance dimension:** highlights managerial transparency, digitalization, participatory governance, international cooperation, knowledge and innovation development, and legal protection.

Overall, these dimensions demonstrate that sustainable development in free trade zones requires a comprehensive and coordinated approach integrating the economy, society, environment, and smart, responsible governance.

Discussion and Conclusion

Economic Dimension:
The economic dimension of sustainable development in free trade zones is based on a coordinated set of strategies and key infrastructures. The primary focus is attracting domestic and foreign investment through tax incentives, reducing investment risk, and ensuring access to reliable financial resources. Indicators such as GDP growth, per capita income, and regional financial health serve as measures of effectiveness. The role of venture capital, angel investors, and innovative ecosystems reflects the move toward a knowledge-based economy.
Simultaneously, the development of international trade through export diversification, increased competitiveness, trade agreements, and strengthening regional branding helps free trade zones become effective links in the global value chain. Advanced infrastructure—such as ports, railways, intelligent customs systems, and reliable water and electricity supply—supports economic growth and facilitates trade. Innovation and technology, through science and technology parks, startup ecosystems, modern technologies, and accelerator centers, act as engines of competitive advantage. Supporting SMEs, strengthening public–private partnerships, establishing industrial clusters, and standardizing production provide a foundation for industrial growth and employment. Furthermore, developing an efficient financial system and moving toward a circular economy with reduced waste ensures sustainable economic growth. Overall, the economic dimension of this model provides a comprehensive, forward-looking structure emphasizing investment growth, innovation, infrastructure, trade, and environmental sustainability.

Social Dimension:
The social dimension emphasizes enhancing human capital, social justice, and community cohesion. Skill development is central, focusing on attracting and empowering specialized labor, digital, technical, and entrepreneurial training, and ensuring educational equity to meet labor market and innovation-driven economic needs. Simultaneously, social justice and human development—considering gender equality, poverty reduction, adequate housing, and youth employment—play a vital role in improving public welfare, preventing unsustainable migration, and fostering social stability.
Security and health, as critical social pillars, focus on data protection, public health, medical services, and insurance coverage, ensuring residents' productivity and quality of life. Cultural and community development, through promoting women's participation,

social vitality, cultural events, and public spaces, enhances both quality of life and local identity. Finally, participatory management and stakeholder engagement ensure citizen and civil society involvement in decision-making, facilitating participatory governance. In sum, the social dimension is foundational to sustainable development, ensuring a capable, healthy, and engaged human capital supports all economic and institutional programs.

Environmental Dimension:

The environmental dimension emphasizes pollution control, resource management, and ecosystem protection. Given industrial growth and population increase, air and wastewater pollution control, waste management, and environmental monitoring are crucial. Measures such as recycling, energy efficiency, renewable energy, and clean transportation reduce greenhouse gas emissions and improve life quality. Expanding green spaces, protecting biodiversity, and implementing tools like Environmental Impact Assessments (EIA) and sustainability reporting prevent environmental degradation and enable monitoring of development performance.

Adaptation to climate change and risk/crisis management are essential for environmental sustainability. Programs such as flood and drought resilience, green architecture, energy-efficient buildings, and urban regeneration address climate challenges. Strengthening crisis management systems and insurability enhances rapid recovery post-disasters. Overall, this dimension emphasizes that economic development must proceed alongside environmental protection to prevent irreparable damage and maintain sustainable development pathways.

Governance and Legal Dimension:

The governance dimension emphasizes transforming management structures, transparency, and participatory governance. Key elements include reducing bureaucracy, accelerating licensing, combating corruption, and establishing e-government. Regional governance and active stakeholder engagement facilitate decentralization and build public trust. Smart city development—relying on digital infrastructure, open data, intelligent urban systems, and financial transparency—enhances efficiency and reduces corruption.

At the international level, economic diplomacy and collaboration with universities and global research centers strengthen free trade zones' position in the global value chain and attract investment. Additionally, research and development, knowledge management, organizational learning, institutional resilience, and strategic decision-making capacity are reinforced. Protecting intellectual property rights and reforming related laws are prerequisites for a knowledge-based economy and innovation attraction. In sum, the governance dimension serves as the backbone supporting economic, social, and environmental development, emphasizing smart, transparent, and participatory governance.

Comparative Analysis with Previous Studies

Comparing these findings with prior studies in Iran and other countries shows that most research has addressed development in free trade zones in a segmented manner. In

contrast, this study systematically integrates economic, social, environmental, and institutional dimensions.

- **Economic dimension:** Previous studies (e.g., Abedi Abshahmadi et al., 2023; Dahrmordegh Ghalehno, 2019; Nahan et al., 2025) focus on improving economic indicators, attracting investment, and enhancing efficiency, whereas this study also emphasizes economic justice, green productivity, and interregional development gaps.
- **Social dimension:** Findings align with studies like Qaderi et al. (2025) and Seyed Alipour & N. Khakshour (2019), which highlight cultural and social threats such as lifestyle changes, inequality, and insecurity, but this study considers structural and long-term impacts.
- **Environmental dimension:** While studies such as Jangi-Zahi et al. (2022) and Gao et al. (2025) explore environmental effects of free trade zones, this study stresses the lack of effective environmental governance and the underuse of green technologies, highlighting the need for institutional reform.
- **Governance dimension:** Findings are consistent with Pourdadash et al. (2023), Kamosi Alamdari et al. (2021), and Wang & Kong (2024), which identify weak management, lack of transparency, and insufficient strategic planning as barriers. This study, however, integrates these dimensions and emphasizes a forward-looking, participatory, and justice-oriented policy approach.

Recommendations for Policymakers

Economic Dimension:

Establish a regional joint innovation and investment fund with government, private sector, and foreign investors' participation. This fund should facilitate financing for industrial, startup, and infrastructure projects, offering tax incentives, supporting venture capital, attracting angel investors, and promoting exports and technology. This will reduce investment risk, enhance competitiveness, and strengthen international market presence.

Social Dimension:

Develop comprehensive skill, employment, and entrepreneurship centers focused on youth and women. In collaboration with educational institutions, knowledge-based companies, and NGOs, these centers will provide digital, technical, and entrepreneurial training, educational equity, and career pathways, facilitating sustainable employment, poverty reduction, and prevention of labor migration.

Environmental Dimension:

Implement an integrated environmental and sustainable energy management system based on modern technologies. This includes online pollution monitoring, advanced

wastewater treatment, industrial recycling, and renewable energy production (solar and wind), complemented by clean transportation, green spaces, and green architecture. These measures align with Environmental Impact Assessments and sustainability objectives.

Governance and Institutional Dimension:

Establish an independent "Smart Governance and Regional Diplomacy Center" in each free trade zone. Responsibilities include implementing e-government, accelerating licensing, ensuring data transparency, institutional risk analysis, international engagement with universities and countries (especially neighbors and strategic partners), and protecting intellectual property. This entity should be participatory, accountable, data-driven, and enhance stakeholder coordination.

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