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Impacts of the Belt and Roads Initiative on Sustainability: Local Approaches to Spatial Restructuring in the Aras Special Economic Zones

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Abstract: Spatial restructuring and regional economic development are closely associated with sustainability. Despite the considerable literature on urbanization's impact on sustainable economic development and urban expansion, few studies have explored how FDI-led spatial restructuring affects the sustainability from a local people perspective. To fill this gap, in-depth interviews were conducted with 516 residents of Aras special economic zones in Iran to assess the impacts and responses to economic shifts and spatial restructuring resulting from the Belt and Road Initiative since 2013. Using the DPSIR framework and sustainability index as an evaluation tool, we assessed the degree of sustainability and viable uplift at the regional level. The Genetic Algorithm (GA) was also utilized to determine optimal values based on local approaches. Results indicate that regional heterogeneity, excessive state pressure, and development imbalances impact the study area. The findings enrich the theory of sustainability and can guide the formulation of spatial restructuring, decision-making, and policies at different stages of regional development. In addition to financial progress, people-centered development planning using local approaches should be a component of the development of special economic zones.

Keywords: regional development; the Belt and Road Initiative; humanized; intelligent and sustainable development; economic changes; regional complex systems; spatial restructuring

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1. Introduction

Economic changes and urban spatial structure influence the attraction of city facilities, which adds greatly to the complexity of municipal settings [1] and branding for city administration concerns [2]. In other words, unplanned and market-driven urban expansion promotes fast evolution while posing sustainability concerns [3–5]. The development process has a considerable impact on the mutual relationships between human societies and the natural environment [6,7].

Development policies and a restructuring plan are thus created as a fresh start. They emphasize competitive advantages to make regions more attractive and prevent degenerative processes [8,9]. The economic changes impact pre- [10,11] and post- [12–15] project assessment, based on the development planning, which is decided by the synergy generated by the project network structure, and determines the efficiency of this program [16]. Foreign Direct Investment (FDI) has been identified as a significant influence on spatial development in emerging economies [9,17–19].

As part of national strategic objectives to assure competitiveness, the number of mega-scale development projects and mega-events has increased considerably in recent decades [20–22]. Providing cross-border infrastructure links along Eurasia, the Shanghai Cooperation Organization (SCO) and the Belt and Road Initiative (BRI) represent a multinational platform [23]. Regional governments justify mega-events by stressing their legacy value and believing they will benefit all residents [21]. Moving the current community, repairing the built environment, and upgrading traditional forms are all part of the restructuring [8].

The fundamental socio-spatial restructuring process has resulted in a variety of both positive and negative outcomes, as well as numerous, complicated and sometimes contradictory effects [24]. While certain groups and those involved in the process benefit economically from its strategic provisions, others' interests are excluded from economic changes. To achieve a challenging balance between stakeholder approaches and assessing the role of foreign direct investment, policies need to develop restructuring and development plans that are appropriate, effective, and integrated [25–28]. Furthermore, the UNSDGs remain a complex topic, with various aims and agendas, as well as a scarcity of in-depth studies on the regional sustainable economy [29–31].

In this study, we conducted a case study analysis using in-depth interviews with locals in the Aras SEZs, East Azerbaijan province, to gain broader insights about the viability of the AFTZ within the BRI context for sustainable development. The causal relationships between BRI-driven economic changes in the spatial restructuring process of AFTZ were assessed through the drivers, pressures, states, impacts, and responses, through in-depth interviews with locals. Using the DPSIR framework as an evaluation tool, we assessed the degree of sustainability and viable uplift at the regional level. The Genetic Algorithm (GA) was also utilized to determine optimal values based on local approaches.

This study examines regional sustainability inconsistencies and BRI-driven economic changes since 2013 to determine whether regional sustainability increases or decreases as a result of economic change and whether local responses to spatial restructuring favor or oppose the long-term viability of planned initiatives. As a practical application of the SDGs' theory about resource flows and their embedded social connections, spatial restructuring using local approaches is presented as a reliable method to adjust BRI-driven strategies to suit their inner SEZ conditions.

The findings indicate that SEZs and local governments need to adapt their economic development strategies to meet the local conditions they face. Two important discoveries from our research deserve special mention. First, this study examines the emergence of BRI-led spatial restructuring and sustainable development from the perspective of residents with empirical evidence from Aras SEZs. To evaluate spatial restructuring, the Sustainable Spatial Development Index (SSDI) was used. Second, the present study developed a theoretical framework based on spatial restructuring from a local perspective. This framework explains the multi-dimensions of sustainable development within the dynamic spatial restructuring process. From a broader theoretical perspective, diverse regional forms of sustainable development in Aras SEZs contribute to the understanding of sustainable development based on a localized approach.

The remainder of this paper is organized as follows. Section 2 includes a comprehensive evaluation of the literature on previous research and its strengths and flaws, to elaborate on existing progress and knowledge gaps. Section 3 presents a theoretical framework and model dedicated to identifying local responses to BRI-driven economic changes in SEZs' sustainable growth, as well as local approaches to the long-term viability of planned initiatives. The study area and in-depth interviews are described in Section 4. It explains how the DPSIR framework is used and formulates and assesses the degree of sustainability and viability of inner-SEZs at the regional level in Section 5. Section 6 shows the test results, and Section 7 discusses them. Section 8 concludes the paper.

2. Literature Review

Due to the increasing number of international events aimed at boosting competitiveness in the global economy, understanding economic progress and urban spatial structure is crucial for long-term development in SEZs [32]. Sustainable development necessitates the commitment, support, and engagement of the government, businesses, and the people [33].

Improving environmental quality has become a crucial proposition for society's sustainable development [34]. Traditional development stages have balanced regional spatial structures, with small towns and cities. However, at the higher development stage, where stringent urban spatial growth management is applied, economic development will be hampered [35].

Different methods for sustainability and spatial restructuring assessments have been utilized, including the analytical hierarchy process approach [36], urban expansion as an evaluation index [37], GIS-based spatial correlation analysis [38], temporal–spatial evolution [33], a regional sustainability strategy [39], and the effect of SEZs on FDI [40], to assess strategic sustainability, spatial expansion, demographic changes, regional new and old driving forces, zoning methods, and place-based policy, respectively. Differences in regional industrial structure and spatial restructuring result in sustainability differences. Consideration of the temporal–spatial evolution of the new and old driving forces can contribute to industrial restructuring and sustainable economic development [33].

Traditionally there are two types of development: (1) top-down urbanization driven by urban governments, and (2) bottom-up urbanization led by regions [37], in terms of driving forces. However, with the intensification of globalization, FDI has played a major role in economic development and these processes change the economic structure and regional industrial structure [35]. Overly intense government supervision limits benefits to participants [37], while developing common goals and promoting stakeholder cooperation improve efficiency [41]. This requires a study of local approaches to adjust development strategies to suit their different environmental conditions [42].

Prior studies addressed the questions "what", "when", and "where". Understanding economic progress and spatial structure [40,43] is vital for sustainable development. Socio-spatial indicators answer "why" and "how", including location information, impacts, and visualization. It is vital to consider quantitative methods for systematically evaluating remodeling courses for sustainability and identifying key aspects [44].

According to our knowledge, there has not been enough research done on the dynamics of the causal link between spatial restructuring and economic change [45,46] for sustainable development based on local approaches to Special Economic Zones (SEZs), which requires additional research. By mapping socio-spatial results to economic activities and spatial restructuring processes, this study extends beyond mere magnitudes and values. It is essential to take a more holistic approach to the evaluation of local feedback (results and responses) during and after the restructuring process.

This study has enhanced the theory of sustainable development to fill current gaps. First, an innovative method for measuring sustainability by investigating causal relationships between economic changes and spatial restructuring is developed. Second, to ensure the long-term effectiveness of BRI strategies, creative assessment procedures based on local responses were developed. Third, the dynamism of spatial restructuring and sustainability is investigated in the context of cross-border collaboration to enable the thorough engagement of local people in decision-making and sustainable development.

3. Theoretical Framework

A long-term development strategy requires empirical and policy studies that consider competing interests, local community engagement, spatial restructuring, and economic changes. The theoretical framework is dedicated to identifying regional responses to BRI-driven economic changes in SEZs' sustainable growth, as well as regional approaches to the long-term viability of planned initiatives.

DPSIR Framework and Indicator System Based on SDGs

According to the DPSIR framework, Pressures (P) are created in a specific area by drivers (D), which may be social, economic, or spatial changes. The state (S) of the system varies as a function of these pressures (P). There is an impact (I), which can be social, economic, or spatial, which leads to a societal response (R). Drivers, Pressures, States, and

Impacts can all be affected by the response [47]. The DPSIR model was used to assess regional sustainability [48–50].

DPSIR's theoretical and applied research relies on strong data support, the dependence of the final threshold on individual cases, and difficulty in grading evaluation outcomes [48,51]. As shown in the cycle below, there is a cause-and-effect relationship [52] among actions D, P, S, and I and reactions in response (R) to them. The main driving (D) force here is BRI-driven FDI, which causes economic changes, and socio-spatial pressures (P) on the inner SEZs state of the AFTZ, which impact regional spatial sustainability, and taking various reactions to restructure by locals is the response (R) (check Figure 1). When actions cause reactions, competition is formed. However, when interactions lead to cooperation, "coopetion" is formed by adding cooperation and competition aspects of different interests.

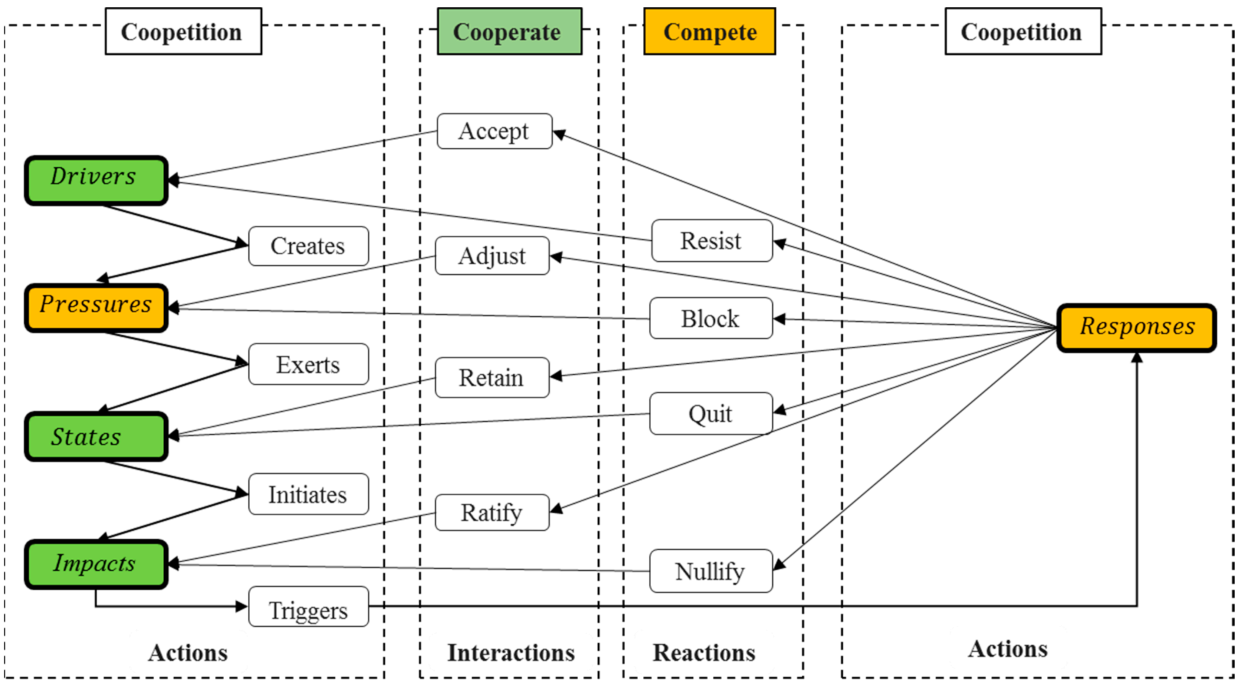

Figure 1. DPSIR framework used in the research.

Each indicator was determined by considering the following: how is it related to the case study's policy objectives and the overall development concept's priorities? Could this indicator be used to assess the efficiency and interaction of spatial patterns that resemble balanced spatial development? How effective is the indicator at providing change-sensitive data to improve decision-making? How well does the indicator get understood by community members, planners, and decision-makers? According to [53], based on previous constraints and the notion of sustainable growth, we investigated sustainably and restructured spatial development indexes using a modified DPSIR model as shown in Fi.

The driving (D) and impact (I) forces are positively correlated [54], and the state (S) indicators are positive, which are essential for sustainable spatial development due to progress on regional strategic planning and are an asset in terms of time and capital invested. The pressure (P) and response (R) indicators are also negatively rated due to the challenge and non-conservative outcomes they pose for local interests, but are also positively rated in some studies [48,54]. The indicators were classified into factors based on their dynamics and explanations of their interactions. The 40 key points and insights of DPSIR are presented in Table 1.

Table 1. DPSIR's key points and their purposes/insights.

DPSIR	Number	Key Points and Their Purposes/Insights
Drivers	9	Contribution of FDI, financial contributions, managerial abilities, technological know-how, exports, economic vitality, equity, industrial structure, enterprise strengthening, and the SDGs.
Pressure	9	Pressures on green spaces, local spatial growth, land availability and cost, affordable housing, environmental pollution, recreation and entertainment centers, and the SDGs.
States	8	States of the geographical distribution of FDI, quality urban space, land use change, accessibility to economic areas, low-cost housing, sanitation systems, transportation systems, and the SDGs.
Impact	8	Impacts on ecosystems, spatial governance, inequality, demographic changes, population density, human capital, social cohesion, well-being, and the SDGs
Response	6	In response to economic transition, spatial development, environmental pollution, identity, emigrants and expatriates' communities, regional issues, and the SDGs.

A description of the research process is included in five phases (Figure 2), for a sustainability analysis aimed at improving spatial identification by applying local perspectives.

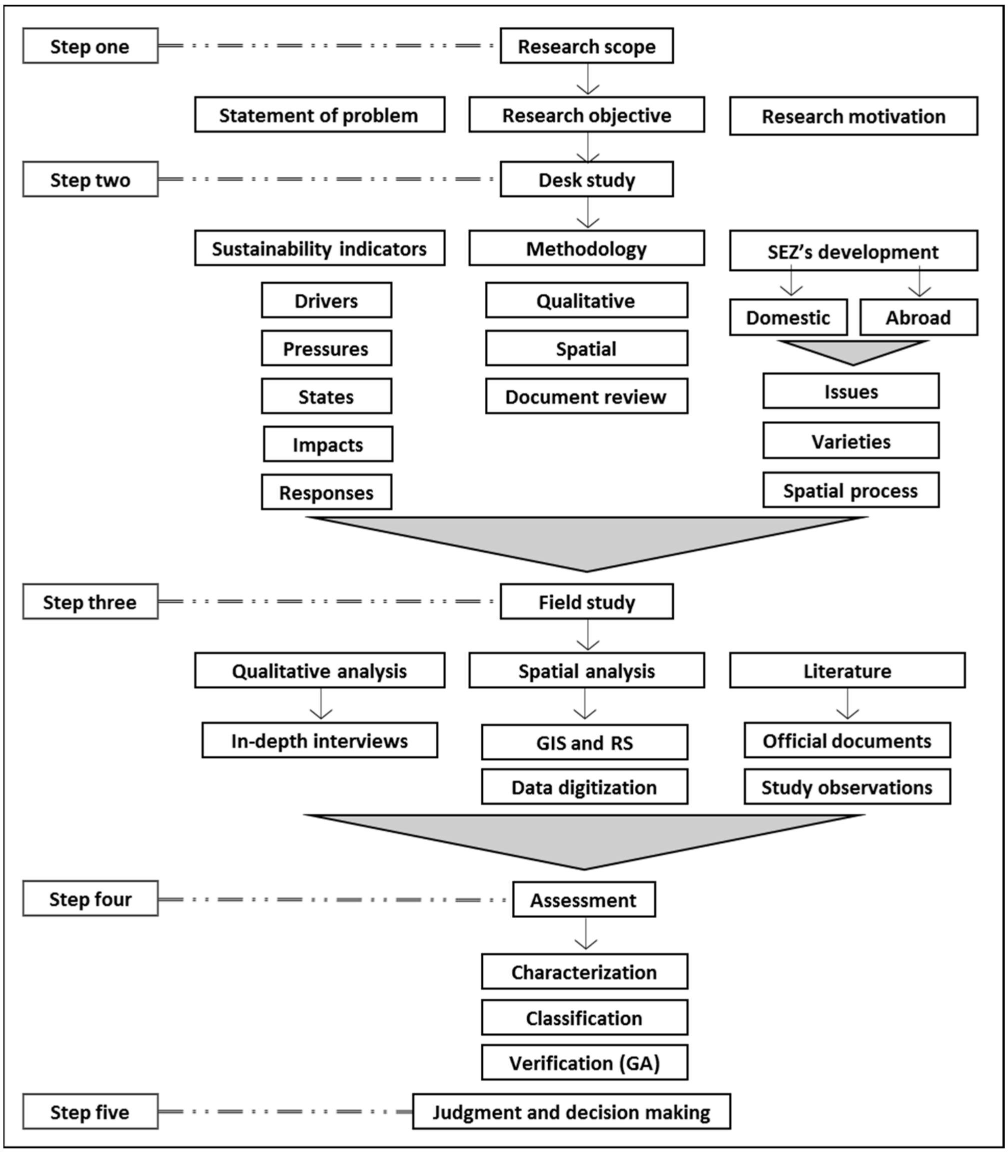

Figure 2. Flowchart of research processes.

4. Materials

In this study, we conducted a case study analysis using in-depth interviews with locals in the Aras Free Trade-Industrial Zones (AFTZs), East Azerbaijan province, to gain broader insights about the viability of the AFTZ within the BRI context for sustainable development. The causal relationships between BRI-driven economic changes in the spatial restructuring process of the AFTZ were assessed through the drivers, pressures, states, impacts, and responses through in-depth interviews with locals.

4.1. Study Area

The Aras Free Trade-Industrial Zone (AFTZ) along the Asia–Europe and Silk Road corridors in the Islamic Republic of Iran were selected as the case study area. Reasons include its ① geostrategic importance for Iran and the BRI, ② capacity as a free trade and industrial park and proximity to European and CIS consumer markets, ③ diversity in terms of geographical, natural, historical, cultural, economic, and spatial aspects, and ④ timing; the region is in the early stage of spatial development and has capacity for spatial restructuring and uplift based on SDGs. The AFTZ covers sections of Jolfa-Hadishar-Marand (R1), Siyahrood-Ayri (R2), Noorduz (R3), Khodaafarin (R4), and Golibeiglu (R5). The AFTZ's different geospatial features are depicted in Figure 3.

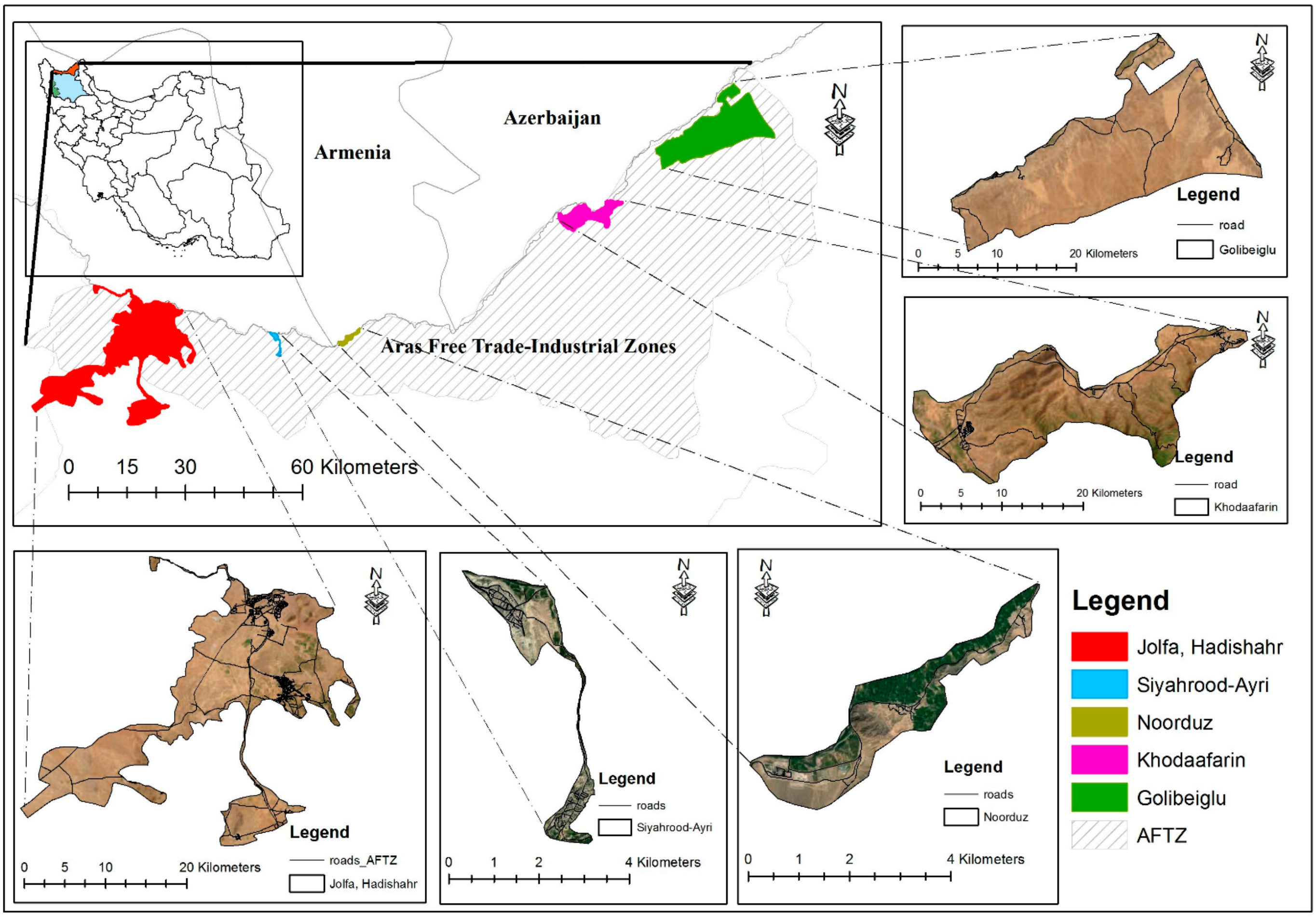

Figure 3. Schematic diagram of the five major regions in the AFTZ.

4.2. In-Depth Interviews

In-depth interviews are an effective research tool for gathering extensive information and ideas on a variety of issues. In-depth interviews provide greater knowledge of the intricate interplay between human activities and the built environment when it comes to sustainability and public participation in the planning and spatial restructuring process. An in-depth interview, through a questionnaire, was conducted with local people to assess the extent to which sustainability-specific spatial restructuring is occurring within the Aras Special Economic Zones, as well as the development paths and planning in emerging sustainability-related BRI strategies. The DPSIR model, which stands for driving forces, pressures, state, impact, and response, is one framework used during these interviews. All five were used to assess various aspects and elements of sustainability. During in-depth interviews, DPSIR seeks to investigate actions, reactions, and interactions that clash with or contradict the norms and values of drivers, pressures, states, impacts, and responses. In-depth interviews are conducted to determine the sustainability of the Aras SEZs and develop strategies to deal with this challenge, by examining planning methods, strategies, and spatial restructuring. Our research study delved into the complexities of each component of the DPSIR model through in-depth interviews, resulting in a thorough understanding of sustainability concerns, on the one hand. Combined with a local approach to space, time, and social dimensions, they provided a more comprehensive framework for research, on the other hand. The insights gained from these interviews helped to shape policy, decision-making, and the implementation of sustainable practices for spatial restructuring and BRI strategies in the Aras SEZs. In this study, data from in-depth interviews were used to evaluate the extent and characteristics of sustainability in Aras SEZs from the viewpoints of economic and spatial restructuring. A total of 516 local family heads (mostly men) volunteered to engage in in-depth interviews and were randomly selected. Responding to our in-depth interview questionnaire took 30–50 min on average.

4.3. Collecting Data, Inquiry, and Reliability Estimation

The data for this analysis originated primarily from questionnaire interviews conducted in the study area. Considering the representativeness and comprehensiveness of the interviewees, 516 households from all over the Aras SEZs voluntarily participated. These households included R1 (238), R2 (36), R3 (31), R4 (68), and R5 (143) heads of the household. The sample of participants that participated in this study had a 95% confidence level and a margin of error of 1.92 percent. All participants were drawn from local communities through voluntary participation.

4.4. Field Works

As part of the study, we examined the local approaches to drivers, pressures, states, impacts, and communities' responses to BRI strategies in Aras SEZs' five distinct regions. The distribution of activities revealed whether or not economic changes and spatial restructuring were evenly dispersed across the Aras SEZs. It also revealed whether or not there were areas or clusters, which was the most direct indicator of BRI's influence on sustainability. Further, we went on to collect planning and policy texts from various sources through various channels, such as the network and the field, to understand the geographical transformation, developmental context, and reconstruction orientation of the AFTZ.

From August 2020 to September 2021, we conducted fieldwork in the AFTZ, primarily observing the physical landscape and regional spatial structure of the AFTZ. The interviews covered topics, such as regional development, the FDI entrance process, BRI strategies, AFTZ spatial transformation, the interactions between various sustainability topics, and strategy planning. Descriptive statistics of individuals are presented in Table 2.

Table 2. Descriptive statistics of individuals (n = 516).

Variables	n (%)	Variables	n (%)
Gender		Number of co-occupants	
Male	464 (89.9%)	Fewer than three	43 (8.3%)
Female	22 (4.3%)	Four or five	220 (42.6%)
Missing	30 (5.8%)	More than five	14 (2.7%)
Age (years)		Single	106 (20.5%)
20 to 30	81 (15.7%)	Missing	133 (25.8%)
31 to 40	171 (33.1%)	Monthly income level *	
41 to 60	153 (29.7%)	USD 0–77.41	6 (1.2%)
Missing	111 (21.5%)	USD 77.42–154.82	28 (5.4%)
Residing duration		USD 154.823–232.23	100 (19.4%)
1 to 5	2 (0.4%)	USD 232.24–309.65	17 (3.3%)
5 to 10	3 (0.6%)	USD 309.65+	8 (1.6%)
More than 10	467 (90.5%)	Missing	363 (70.3%)
Missing	44 (8.5%)	The primary source of income	
Education		Trade	84 (16.3%)
Primary school	1 (0.2%)	Industry	130 (25.2%)
Middle school	2 (0.4%)	Service	189 (36.6%)
High school	43 (8.3%)	Agriculture, aquaculture, and livestock	32 (6.2%)
Collage/university	363 (70.3%)	Missing	165 (32.0%)
Missing	107 (20.7%)	Head of households	
Residency situation		R1	238 (46.1%)
Own	223 (43.2%)	R2	36 (7.0%)
Kinsfolks	113 (21.9%)	R3	31 (6.0%)
Rented	107 (20.7%)	R4	68 (13.2%)
Missing	73 (14.1%)	R5	143 (27.7%)

* Source: based on data from the Central Bank of Iran and the authors' estimation.

5. Methodology

To learn more about the AFTZ's potential for sustainable development in the overall structure of the BRI, after forming a dataset to assess the degree of sustainability and viable uplift at the regional level through a synergistic interaction, the DPSIR framework was employed as an evaluation tool to reveal internal relations and their influence among components [48]. It included sustainability, economic changes, spatial restructuring, and local approaches to incorporate BRI strategies' dynamism. It also clarified the interactions between the inner SEZs.

5.1. Data Standardization and Weight Determination for DPSIR Indicators

For the study assessment, the collected interview data need to be standardized to omit the effect of dissimilar units and measures between indicators [55] and to determine the gravity of each index based on the argument on the index weight [29,56–59]. The Shannon Entropy Method was applied.

To handle disparities in indicator selection, the DPSIR model is entangled in controversy, inconsistency, and subjective judgment; as a response, SDGs adopted systematic guidance—particularly in the selection of pointers alongside related sustainability. Previous academic studies on FDI, public participation, spatial planning [50], broad-ranging evaluations [48,59–61], and sustainable development [49] formed literature for the productive and integrated addition of self-sustaining spatial planning investigations. Indicators and weights used in the DPSIR framework are listed in Table 3.

Table 3. Indicators and weights used in the DPSIR framework.

Criterions	Indicators	Weights
Drivers of FDI in advancing the SDGs		
	FDI financial contributions to the SDGs	0.0163
	Contributions of FDI managerial abilities to the SDGs	0.0247
	FDI technological know-how contributions to the SDGs	0.0337
	Export-led development and industry contributions to the SDGs	0.0099
	FDI contributions to GDP, equity, and the SDGs	0.0130
	FDI's contribution to economic vitality, growth, and the SDGs	0.0189
	Contributions of FDI to economic performance and SDGs	0.0261
	FDI's contribution to the industrial structure and SDGs	0.0245
	Contributions of FDI to enterprise strengthening	0.0295
Pressure from FDI on SDG progress		
	Pressure on green spaces and SDGs	0.0300
	Pressure on recreation and entertainment centers and SDGs	0.0181
	Pressure on local spatial growth and SDGs	0.0322
	Pressure on land availability and cost and SDGs	0.0285
	Pressure on affordable housing and SDGs	0.0397
	Water pollution and SDGs	0.0501
	Soil pollution and SDGs	0.0461
	Acoustic pollution and SDGs	0.0517
	Air pollution and SDGs	0.0250
State of FDI and SDG progress		
	Geographical distribution of FDI and SDG progress states	0.0157
	States of quality urban space for FDI and SDG progress	0.0216
	States of land use change for FDI and SDG progress	0.0331
	Accessibility to economic areas for FDI and SDG progress	0.0245
	Low-cost housing states for FDI and the SDGs	0.0179
	State of the urban sanitation system for FDI and the SDGs	0.0271
	Spatial development states for FDI and the SDGs	0.0493
	State of the transportation system for FDI and the SDGs	0.0172
Impacts of FDI on SDG progress		
	FDI impact on the ecosystems for FDI and SDGs	0.0179
	FDI impact on spatial governance for the SDGs	0.0231
	Impact of FDI on levels of inequality for the SDGs	0.0152
	Impact of FDI on demographic changes for the SDGs	0.0231
	FDI's impacts on population density for the SDGs	0.0214
	Impact of FDI on the human capital level for the SDGs	0.0203

Table 3. *Cont.*

Criterions	Indicators	Weights
	FDI impacts on social cohesion and regional identity	0.0253
	FDI impact on well-being and welfare	0.0202
Responses: FDI and SDGs		
	Responses to economic transition issues	0.0142
	Responses to spatial development issues	0.0141
	Responses to environmental pollution issues	0.0147
	Responses to social and identity issues	0.0179
	Responses to emigrants and expatriates' community issues	0.0218
	Responses to regional issues	0.0261

5.2. Calculation of the Sustainable Spatial Development Index for DPSIR Indicators

The Sustainable Spatial Development Index (SSDI) was established based on the theoretical framework (see Figure 1) used to analyze and apply the DPSIR model. The SSDI is calculated according to Equation (1), followed by Equation (2) for D, P, S, I, and R, based on adapted prior studies [48,54].

$$\mathrm{SSDI} = \frac{\mathrm{D} \times \mathrm{S} \times \mathrm{I}}{\mathrm{P} \times \mathrm{R}} \tag{1}$$

This calculation has been repeated for D, P, S, I, and R in Equation (2), and summary statistics are accessible in Table 4.

$$\mathrm{S} = \sum_{i=1}^{n} \mathrm{W_{Si}} \times \mathrm{P_{Si}} \times \mathrm{K_{Si}} \tag{2}$$

W_{Si} is the weight of states indicators,P_{Si} is the percentage frequency of factor i, and K_{Si} is a numeric value for the driving force index i, where $i = 1, 2, 3 \ldots n$.

Table 4. Summary statistics.

	Linear Equations	Mean	SD	Min	Max	Weights	Opt. Values	Tendency
Drivers	D = 0.5888 × P + 0.0193	2.93	1.75	0.06	9.94	0.1967	0.0372	+
Pressures	P = 0.0952 × S + 0.0205	4.44	2.69	0.26	13.64	0.3214	0.0206	−
States	S = 0.0196 × I + 0.016	3.66	2.01	0.29	7.98	0.2065	0.0168	+
Impacts	I = 0.0864 × R + 0.0047	8.77	3.21	0.17	13.83	0.1666	0.0070	+
Responses	R = 0.6541 × D + 0.0169	3.18	1.26	0.10	5.37	0.1088	0.0171	−

Note: There are five special economic zones, and the observations cover the period from 2013 to current.

5.3. Reconstructed Index

To assess sustainability and gain local support for provisioned strategies, SSDI values are adjusted to calculate a Restructured Sustainable Spatial Development Index (RSSDI). The aimed RSSDI for the driving force (D_{max}), state (S_{max}), and impact (I_{max}), indicator maximum values for pressure (P_{min}), and response (R_{min}) indicator minimum values have been recalculated in Equations (1) and (2), and the SSDI is subtracted from the RSSDI, and the result is a feasible uplift value at the AFTZ.

5.4. Genetic Algorithm: Optimum Values for Sustainable Development

The GA was then utilized to discover optimal values and the validation process after identifying the fittest candidates in a complex space of solutions using random information exchange.

Using random information exchange, GA finds the most suitable candidates in a complicated space of potential solutions. The validation procedure and optimal parameters for sustainable development were determined using the GA fitness function in MATLAB R2021b. Based on the understanding of sustainable development and the characteristics of the sustainability optimization problem, our objectives can be categorized as follows:

Maximization of drivers.
Minimization of pressures.
Maximization of states.
Maximization of impacts.
Minimization of responses.

The goal of Genetic Algorithms (GAs) is to find the optimal candidates in a complex space of solutions [62], and the optimization algorithm function of GA was also used to determine fitness, assess outcomes, and analyze dynamic interactions within a DPSIR framework.

6. Results

The result and discussion section of the study is devoted to the identification of local responses to BRI-driven economic changes in SEZs' sustainable development to recognize the main anomalies in the AFTZ, as well as local approaches to the long-term viability of planned initiatives.

6.1. Empirical Findings: Determination of Weights and Indexes

According to the study, the weighted values with decreasing importance reported in summary statistics are pressure, states, drivers, impact, and reaction (see Table 4).

Despite the relatively short period of BRI strategies that were implemented through the years since its start in 2013 [30], the current study on the AFTZ provided a methodology to assess the sustainability of the current process and calculate the highest conceivable URSSD based on economic changes. Following standardization for each indicator attribute using the entropy approach to validate weights of dependent indicators and to achieve values, the DPSIR index values for each region were computed. The analysis of complete SSDI values and the RSSDI values, as well as the value of uplift, was determined and verified by the GA. Based on the information in, the region's driving, pressure, state, impact, and response indexes explained the methodology's calculated SSDI values of the DPSIR framework for each of the separate regions in the AFTZ, as presented in Table 5.

Table 5. Region's drivers, pressures, states, impacts, responses, and index values.

Regions	Drivers	Pressures	States	Impacts	Responses	Values	%
R1	4.97	10.86	6.88	3.00	1.31	** 19.46	51.1
	5.72	288.97	3175.19	1586.27	118.39	* 3435.78	
R2	0.67	1.21	1.05	0.34	0.21	** 0.99	6.1
	0.93	36.28	430.04	193.63	18.12	* 410.12	
R3	0.47	1.34	0.91	0.34	0.17	** 0.66	5.0
	0.77	34.59	380.17	192.19	14.09	* 331.93	
R4	1.03	2.34	1.31	0.67	0.33	** 2.00	13.4
	1.39	61.36	633.42	367.07	28.11	* 899.88	

Table 5. *Cont.*

Regions	Drivers	Pressures	States	Impacts	Responses	Values	%
R5	2.05	4.98	2.96	1.18	0.67	** 3.01	24.4
	3.08	134.72	1316.37	780.00	56.41	* 1635.30	
Aras	9.18	20.72	13.11	5.53	2.68	** 26.11	100
	11.90	1.43	14.96	7.31	0.54	* 6713.01	

Note: SSDI: ** and RSSDI: *. Source: Author's estimation.

6.2. Spatial Analysis

According to DPSIR Framework, driving, pressure, status, impact, and response indexes are determined using the outlined methodology.

This was performed for each region in the AFTZ. Figure 4 shows the spatial representation of these five indexes. Figure 5 illustrates the spatial depiction of SSDI values calculated for five distinct regions in Aras SEZs.

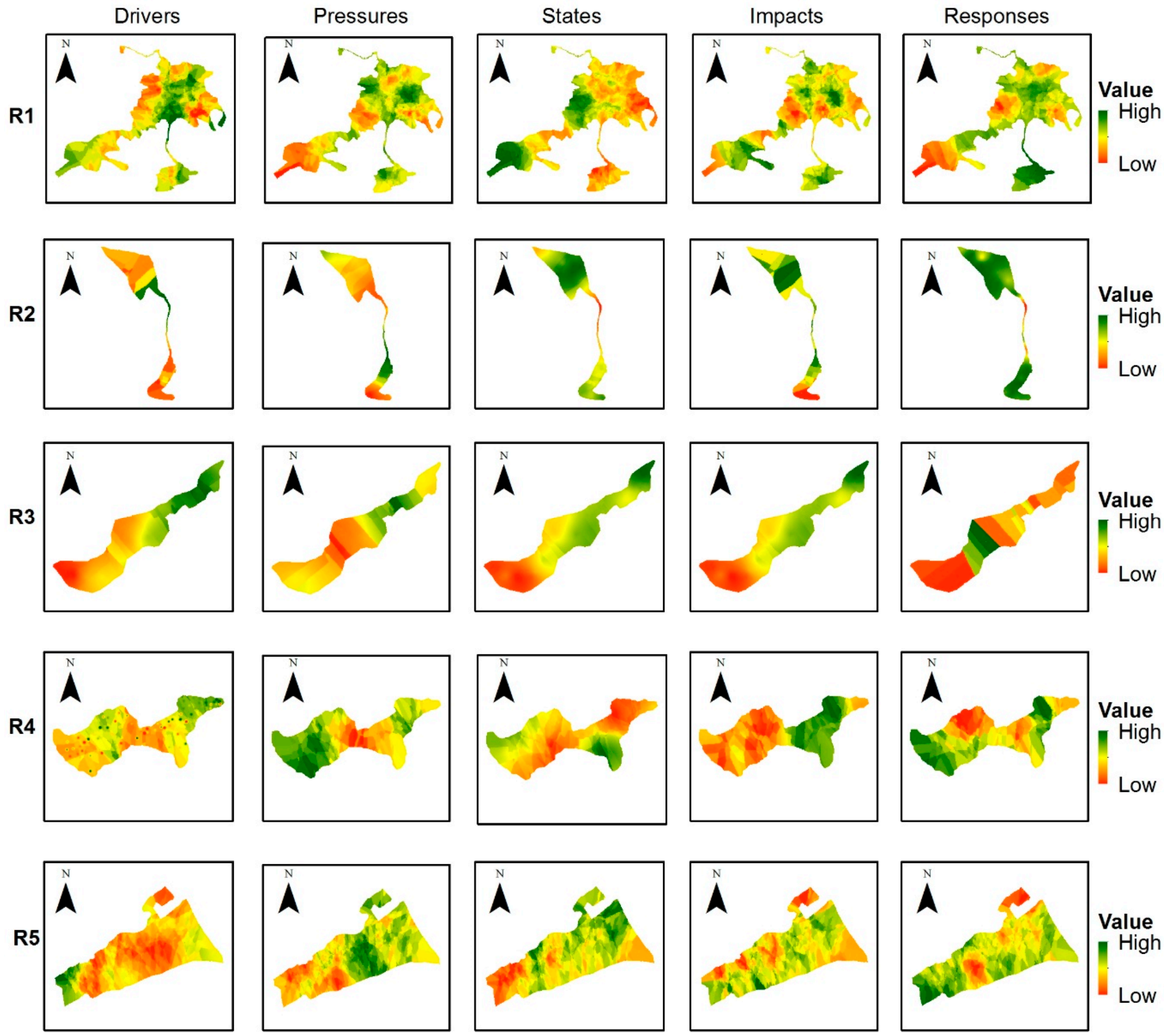

Figure 4. Spatial demonstration of calculated D, P, S, I, and R values for separate areas in the Aras SEZs.

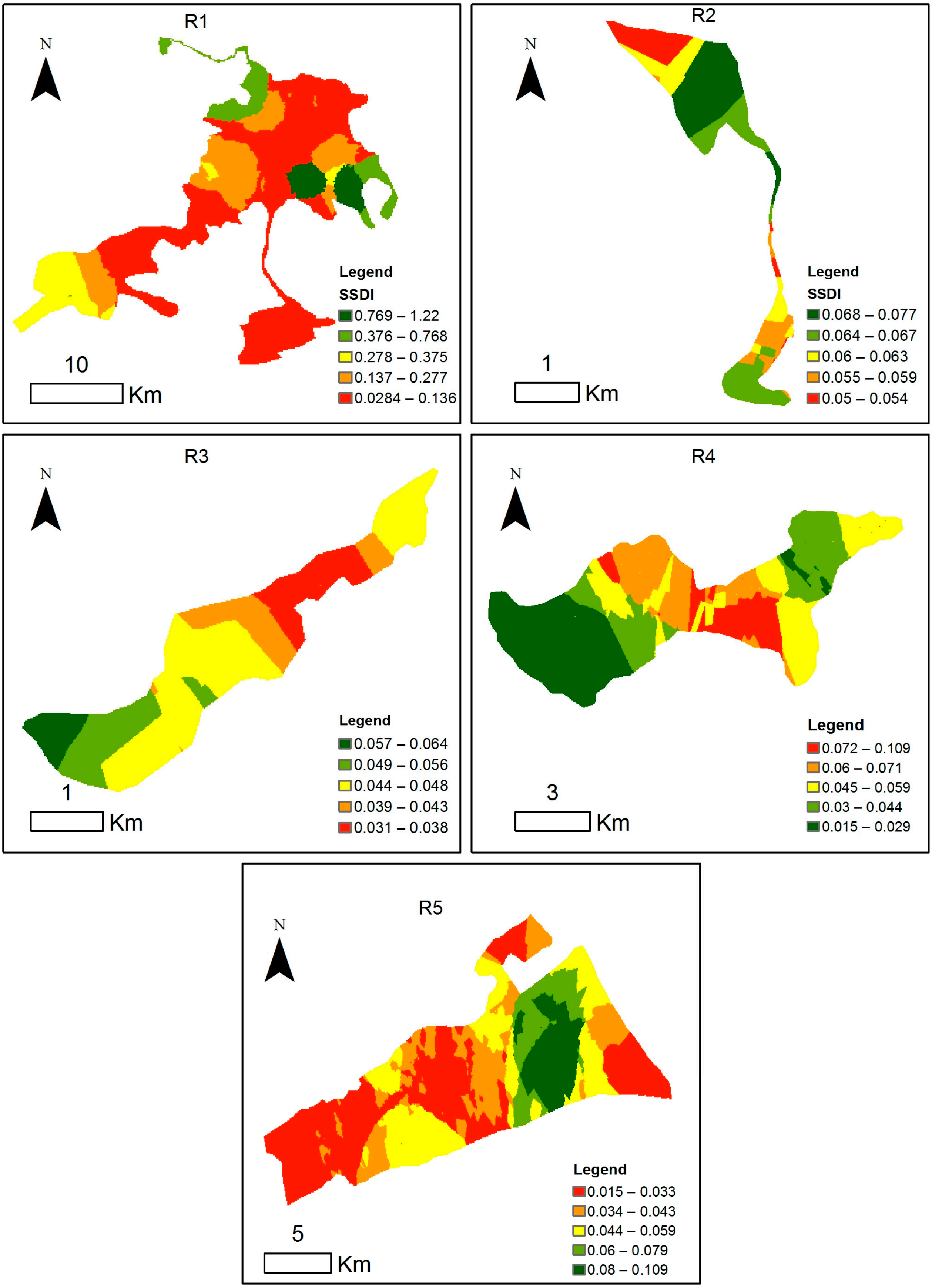

Figure 5. Spatial demonstration SSDI values calculated for areas in the AFTZ.

The URSSD values and the increased amount for each of the pressure (P), state (S), impact (I), and response (I) layers, of five AFTZ regions, were calculated. Even though R1 has height DPSIR forces, SSDI, RSSDI, and URSSD, its calculated uplifting rate increased by about 55 percent compared to its survey statistics. This is the lowest among other regions. The uplifting rate of other regions from highest to lowest compared to survey results is approximately R5 (22.8 percent), R4 (12.3 percent), R2 (5.6 percent), and R3 (4.3 percent). As a result of applied methodology, 64 percent and 56 percent of R2 and R3 are deemed sustainable, while R1 and R2 are deemed unsustainable at 52 percent, with R5 at 53 percent. Figure 6 shows the DPSIR sustainability index results using a set of optimal values determined by the GA for each Aras SEZ.

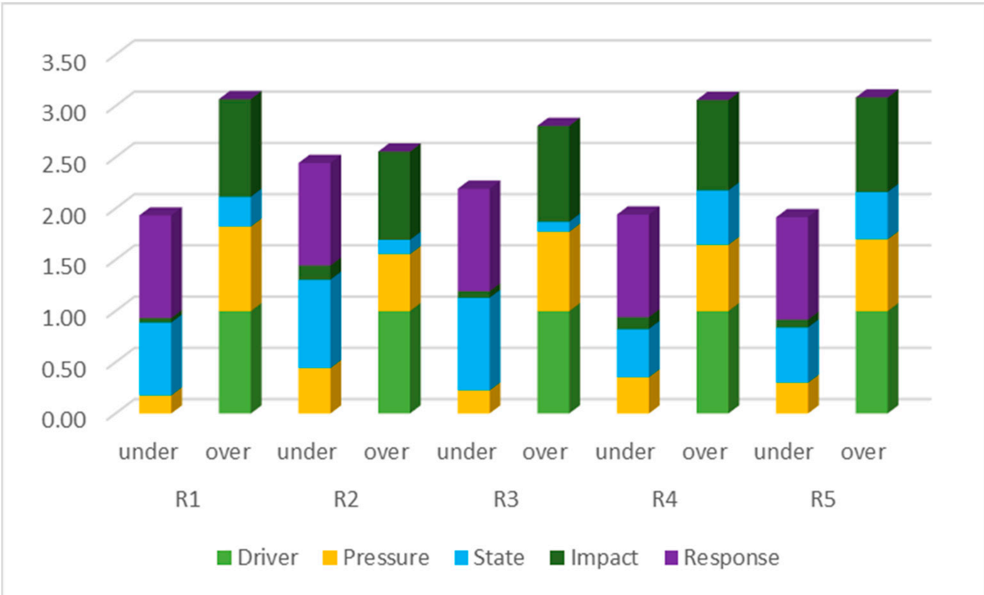

Figure 6. The DPSIR sustainability index results were compared using a set of optimal values determined by the GA for each Aras SEZ.

7. Discussion

The weight of the driver factor (0.0372) is the highest in the DPSIR factors (Table 4) leading us to understand that the current state of the study area has serious sustainability issues. The current total level of transformation in the nations along the "BRI" is still relatively low, according to the study [30], and there is still much opportunity for improvements, which also is true for the research study area.

7.1. Analysis of the RSSDI and Calculated Uplift Values

To adjust the SSDI disparity among regions, a new wave of BRI-directed FDI could act as a driving force for the spatial development of other regions and create an opportunity for redistribution based on the uplift and spatial restructuring of regions at the AFTZ. For this aim among the DPSIR, the framework's action and reaction is adjusted to a synergic interaction. The DPSIR framework formed a constructive relationship with the RSSDI, with values for each driver (D_{max}), pressure (P_{min}), state (S_{max}), impact (I_{max}), and respond (R_{min}) layer of the five AFTZ regions. The RSSDI of the R1 is significantly higher than the RSSDI of the other four regions; however, it is mostly over the sustainable optimal value. The RSSDI of the other four regions also improved significantly, with the average RSSDI value of the AFTZ.

To the best of our knowledge, this is the first study to investigate regional sustainability process-based FDI as a driving factor for economic changes and a local approach to spatial restructuring to evaluate SDGs in a specific study area. Several barriers and facilitators were identified, all of which are consistent with previous research. Some studies used DPSIR research indicators that are comparable to those used in this study, although indicators are used as driving, pressure, status, impact, and react variables in different approaches depending on the various investigation goals.

Despite their differing applications, the study indicators of driving [49,54,60], pressure [30,48–50,54,59–61], state [48,50,60], impact [49], and response [48,50] are the same as those used in other studies on regional sustainability and assessments utilizing the DPSIR framework. In the preceding eight studies, the highest two numbers of indicators were 37 and 39 [48,61], and the average number of indicators was 29.9. However, for an in-depth study and elaborate research, 64 indicators were employed (see Table 3).

Most of these studies conducted for the environment's integrated assessment and driving factor mostly included socioeconomic driving factors, like the population increase, human needs, and industrialization, which in the case of the current study, is FDI. In some studies, the economy is defined as environmental and socioeconomic [50] and the economy is the driving force for unsustainability [60], and one study was about outward FDI [30]; however, socio-spatial aspects of economic changes and spatial restructuring were neglected, which were covered in this study.

7.2. Effects of BRI-Driven Economic Changes and Spatial Restructure on Sustainability

Based on the findings the study area's sustainable spatial restructure, founded on SDGs indicators and BRI-directed economic changes as results, indicate an improvement compared to its survey statistics in the AFTZ. This had a significant impact on its economic development plans [30], as well as rising regional sustainability trends [30] and local approval; different regions in diverse locations, however, have varying levels of sustainable development [30]. The current level of development in the nations of the BRI and spatial structure was rather low, with plenty of space for improvement [30], which was verified by the results of this study. The disparity between the RSSDI and URSSD indicates a low degree of sustainable spatial restructuring and development in the AFTZ and a huge gap to be closed.

Progress by Spatial Restructuring and Uplift at R1 in the AFTZ

The finding of the study suggests that among the five examined regions at the AFTZ, the R1 had the highest spatial uplift, where its performance is the calculated SSDI, and RSSDI values are higher than other regions. Economic growth and managerial duties of decision-makers may surely aid in improving sustainability, and income structure optimization can also aid in promoting sustainable development [30], as well as improving spatial restructuring in the transformation process.

When five distinct AFTZ regions are compared, it is clear that the R1, among others, has a particularly strong foundation and strong performance in regional sustainability and uplifted spatial reconstruction. The significant difference in SSDI between R1 and the other four regions proposes that infrastructure, which is the shortest board in supporting development, could be one of the key reasons [30]. It is also worth noting that the R1's significant spatial development and concentration cause issues for the sustainability of this region reflected by the pressure index of the SSDI.

According to the survey findings aligned with other studies, one of the most significant flaws in the transformation process was infrastructure [30], which could be resolved in the spatial restructuring process, as is obvious based on the RSSDI. Progress could be achieved through economic changes and spatial adjustments; sustainable spatial development indicates that the overall sustainable spatial sustainability of the R1 in terms of the SSDI and RSSDI was higher than that of R5, in impact (I), state (S), and driving (D) factors of DPSIR framework, which directly indicates the region's capability for uplift and transformation.

7.3. Unbalanced Regional Development and Uplifted Spatial (Re) Construction in the AFTZ

Unbalanced SSDI among different AFTZ regions at present, besides RSSDI and URSSDI, shows that it will have distinct consequences on the region's long-term viability and transformation processes. As noted in prior studies [30], the regional sustainability and uplift in five AFTZ regions have revealed a great deal of uneven growth, as well as the necessity for a long-term effort to meet the aims of the BRI and possible spatial restructuring and for the utmost achievable amount by the BRI-driven USSDI. The R1 is relatively developed in terms of urban development; however, sustainability is not balanced.

Besides its geostrategic advantages and land size, the R1 has been among the highly preferable regions of Iran's free trade-industrial zones in terms of its spatiality, trade, and industry development; likewise, chronologically it is also the first nominated region in the AFTZ. Through the analysis of sustainable spatial development, the spatial development of the AFTZ has a substantial unbalanced development. Because of the huge concentration of resources and economic and spatial development, conflicting aspects and problems will arise for the region's long-term spatial structuring.

8. Conclusions

The DPSIR framework was used to assess the sustainability of spatial restructuring by analyzing SDGs-G11, local approaches to BRI-directed economic changes through drivers, pressures, states, impacts, and responses based on analyzing the SSDI, RSSDI, and URSSDI for the AFTZ and its five associated regions. The research study revealed that the DPSIR framework could be wildly used in the regional sustainability and spatial restructuring assessment. This method can not only evaluate economic changes' effects, but it can also disclose the ruling power of economic transformation by analyzing the spatial relativity of each DPSIR indicator. The study showed that rapid regional transformation and uplift for socio-spatial restructuring are multi-aspect challenges. BRI policies affect the economy, industry, and sustainable development due to competitive local interests, economic shifts, and spatial reorganizations.

All of the separate regions in the AFTZ were subjected to spatial policies that ensure environmental protection of adjacent natural protected areas, national parks, and wildlife shelters on hand and the Aras River as a natural and national border and from other sides surrounded by the protected areas, for which each of five regions, because of their unique location and nearby areas, need distinct attention. Also, all the regions' pressure indexes are the highest among other indexes. The ecological protection considerations on the one side and the need for urban infrastructure building, an urban agglomeration, economic development, spatial positioning, local land use, recreation areas, and pollution are the main pressure indicators.

The findings of our study imply that for economic development strategies at the inner-SEZ level, the policy framework imposed on AFTZ local governments should be altered to allow them to customize their spatial restructuring and development to their very diverse local realities.

Throughout this research study, we also have some limitations; first, due to communication issues (mainly COVID-19), abnormal data, often incomplete/missing data, and other factors all affected the accuracy of the data collected through the questionnaire. Second, different administrative approaches and strategies were used in different regions of the AFTZ resulting in a weak relationship in the assessment of different regions. Third, because the DPSIR framework was only used in the AFTZ, the feasibility of study findings may not be particularly applicable to other contexts. The method of evaluating regional sustainability and uplifted spatial restructuring is based on entropy and weight analysis, but it cannot fully use this based on location and geographical (GIS) data and analyze it.

For further research, a separate investigation focused on a holistic local approach to location-based objectives and regional capability could be considered. Also, various aspects of sustainable development are linked with location and spatiality, which need further investigation from local perspectives. To provide objective research conclusions, and to obtain closer-to-real-world scenarios regarding BRI strategies and sustainable SEZ development, data types should be improved, and more types of data should be included, including neighboring relations, fragmentation, facilities, morphology, road networks, and land use and land cover data.

8.1. Limitations

An overview of the key influencing factors of the BRI on sustainability, along with local approaches to spatial restructuring research, was provided as the starting point for this study. A method that uses a local approach examines the origin of change, changes in economic conditions, and changes in spatial structure. The DPSIR framework is used to evaluate sustainability components of economic and spatial restructuring research in Aras SEZs based on their characteristics.

Although these are common topics in sustainability research, by establishing a link between these aspects and the fundamental elements of sustainability research, such as the starting point, process, and destination, the shortcomings of sustainability could be discovered more comprehensively and intuitively, improving the efficiency and integrity of the sustainability research.

8.2. Recommendations

In response to the current issues related to the impacts of the BRI on the sustainability of the economic and spatial restructuring in Aras SEZs, the following recommendations are put forward:

(1) The distribution of BRI-driven FDI should match the distribution of the residents and local approaches: in addition to further increasing the number of businesses and spatial restructuring, special attention should be paid to improving the equality level of the community for regional sustainability. Due to a lack of a proper match between economic activity and local spatiality, economic and infrastructure facilities cannot serve all local citizens fairly and reasonably. This will lead to excessive pressure on states in the region and unconstructive competition. By increasing regional economic and spatial restructuring, it is important to take the relationship between local approaches and opportunities into account, ensuring that everyone has equal access to BRI-driven FDI resources while ensuring that residents are consulted in decision-making to foster the development of vigorous BRI strategies and sustainable growth.

(2) Spatial restructuring improves the economy and improves accessibility: Aras SEZ urban construction is in a phase of spatial restructuring and new economic development, which coincides with the weak areas of poor support for BRI in Aras SEZs. According to the research, planned FDI allocation improves local support and affects sustainability. Using the spatial restructuring process, planning public service facilities based on geographical space and population distribution, along with intended projects, could improve local support and accessibility concerns. To achieve sustainable development, urban renewal must be combined with the revitalization of the current structure to create economic changes and spatial restructuring.

(3) Aras SEZs could benefit from the composite utilization of BRI-driven FDI and local approaches: opportunities for economic opening and spatial restructuring. For regions with limited space, integrating smart city planning and facilities could be an effective method. DPSIR functions can be combined with smart economic and spatial restructuring to integrate regional sustainability into SEZ stock spaces in an increasingly diverse and flexible way.

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Abbreviations

Symbol	Nomenclature
n	Number of interviewees
SSDI	Socio-Spatial Development Index
D_i	Driver indicators
P_i	Pressure indicators
S_i	States indicators
I_i	Impact indicators
R_i	Response indicators
D_{max}	Maximum feasible driving index
S_{max}	Maximum feasible states index
R_{max}	The maximum feasible response index
GIS	Geographic Information System
R_{Di}	Relative frequency
F_{Di}	Frequency of factor
n_D	Number of observations
P_{Di}	Percentage frequency
W_{D_i}	Weight of driving factor
K_{D_i}	Driving force index numerical value
RSSDI	Restructured Socio-Spatial Development Index
P_{max}	The maximum feasible pressure index
I_{max}	Maximum feasible impact index
Opt. values	Optimal values
RS	Remote Sensing

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