Research Paper: The Capacity of Rural-Urban Linkage and Spatial Changes in the Rural Settlement (Case Study: Damavand County)

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ABSTRACT

Purpose: This study investigates the capacity of rural-urban linkages and the spatial flows of ru-ral settlements. Thus, the study explores the spatial flows that influence various rural spatial as-pects in Damavand County as the capacity of the rural-urban linkage.

Methods: The present quantitative study adopted a descriptive-analytical approach to study 370 households selected randomly from the research samples of 29 villages from 83 villages in Damavand County.

Results: The findings of spatial evaluation revealed that " If established correctly, these flows will cause a consistent transformation in the rural space's social, economic, ecological-environmental, and physical aspects. However, overlooking the capacities of rural-urban linkage in the framework of spatial flows would cause incompatible changes in indices, including the population, economy, land use, physical features, and housing in villages.

Conclusion: The results of the structural equation method revealed that the flow of people had the most significant impact on spatial transformation in the studied area and goods. In contrast, service flows had the most negligible considerable implications in the studied region.

1. Introduction

Rural-urban linkages result from a "reciprocal interaction" between a region's urban centers and rural settlements. Douglas emphasized the spatial evolution and structural change of rural settlements based on the capacities and facilities of the links influenced by the five spatial flow frameworks established between urban and rural areas in the framework of the regional development process. Douglass defines the chain of spatial interaction and connection (e.g., the flow of people, money, goods, information, and services). The chain connections across economic sectors (agri-

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culture, industries, and services) make up the capacities and facilities of rural-urban linkage in a region, leading to spatial changes in urban and rural settlements (Douglass, 1998; Tacoli, 2003; Shafieisabet & Azhariyanfar, 2017). The capacity of bonds and spatial flows refer to the transfer of agricultural and other producers from rural to urban areas and transferring of industrial foods from urban centers to rural settlements, which influence the spatial changes on both ends of the flow (Tacoli et al., 2017; Douglass, 1998). Thus, taking advantage of the capacity of rural-urban linkage will cause a balance between villages and cities in the same regional spatial organization (Friedmann, 2004). This subject is why urban and rural planners have invested significant efforts in removing the gap between these two centers through development plans at various regional and district levels (Douglass, 1998). Hence, rural and urban planners seek policies that take advantage of the capacities of rural-urban linkage toward the spatial changes in the settlements. Considering urban and rural plans and programs are separate and even contradictory. The long reign of fractional attitudes and growth poles has posed various challenges to the spatial changes of rural and urban settlements in developing countries such as Iran. The capacities of rural-urban linkage have acquired much attention over the recent decades from various aspects in the framework of regional network strategies seeking to attenuate these challenges and avoid functional and spatial disintegration of the linkage between urban and rural areas. However, rural-urban linkage can only be consistently influential in rural settlement transformations as long as the tangible and latent capacities and facilities of sectoral and spatial flows are used for functional and structural change (Douglass, 1998; Shafieisabet & Mirvahedi, 2021).

Therefore, negligence towards the capacity of rural-urban linkage leads to improper utilization of the human and natural resource capabilities on both ends of the spatial flow between urban and rural settlements and challenges the opportunities to produce wealth, investment, employment, etc. The secluded approach to rural and urban planning and overlooking the facilities and capacities of the rural-urban linkage in the framework of spatial flows in the studied area have resulted in inconsistency and severe challenges in the establishment and expansion of the infrastructural services and manufacturing and job opportunities in the rural settlements of Damavand County in terms of spatial changes. Thus, exploring the capacities and facilities of rural-urban bonds in the framework of regional development planning and the policy-making system will lead to a consistent spatial change in rural settlements. Following this end, the present study seeks to identify the tangible and latent capacities of the rural-urban linkage and their impact on the spatial changes of the rural settlements in the studied area in the aspects of population, economy, land use, physical features, housing in villages, etc.

2. Literature Review

Douglass presented rural-urban linkage and regional network strategy theory in 1998. His theory's structure and conceptual constructs encompassed the spatial flows, such as the spatial chain interaction and connection of the flows of money, people, goods, capital, information, and waste. Sectoral flows were another conceptual construct of this theory and encompassed the chain linkage between the socio-economic sectors in each district and region. He also believed planning for cities and villages separately would disintegrate the rural-urban linkage, so consistent growth and development would be achieved through complementary linkage and organized bonds between urban and rural areas across a region (Douglass, 1998). He believed that negligence toward the capacity of rural-urban bonds would place the most significant focus on the development processes on urban nodes, regardless of the rural areas. This will cause a polarized growth model emphasizing the role of urban centers or nodes as the primary development actors and create top-down sectoral planning that will leave incompatible and negative impacts on spatial development in rural settlements. The theory of the rural-urban relation emphasizes a decentralized planning system with multi-sectoral (inter-sectoral) cooperation and integration and rural-urban activities at the local level (Douglass, 1998; Shafieisabet & Mirvahedi, 2021). Building on Douglass's theory, Tacoli found that rural-urban relation flows and facilities formed between urban centers and their surrounding rural settlements can be a fundamental factor in significant spatial changes in urban and rural settlements (Tacoli, 2004; Muloi et al., 2022).

Rural-urban linkage influences the transformation of rural settlements since most rural households migrate to cities, and demographic exchanges are thus observed between urban and rural settlements. The labor force demanded in urban centers results in the migration of large numbers of rural unskilled or semi-skilled workers, leading the population to undergo an increasing trend in cities and a declining trend in villages. The return of villagers from cities to their villages and the development of second houses changed the structure and form of housing in villages inspired by cities. The villages imitate the appearance and design of housing in cities, which will cause extreme physical transformation in villages and diminish their rural and pristine appearance. Thus, broad changes are created in the size, land use, housing, and various socio-economic functions of villages (Tostensen, 2004; Eftekhari et al., 2011). As mentioned, rural-urban linkage leads to spatial changes in settlements. The classic linkage between the rural and urban centers can create flows that influence infrastructural-physical, economic, social, and environmental-ecologic aspects and thus result in spatial changes in settlements (Kammeier, 2003). However, an accurate understanding of the linkage between urban and rural environments can contribute to functional and structural changes in their linkage and establish the proper linkage. Thus, the knowledge and analysis of rural areas and settlements' spatial function and structure and paying efforts towards their functional and structural organization and improvement of the linkage governing them aren't among the essential measures without which the suitable grounds for the transformation of rural settlements. This subject is how rural-urban linkage can influence sectoral and spatial flows (Saeedi, 2011).

A review of the previous research on rural-urban linkage and the spatial changes of rural settlements is briefly mentioned in the following:

Shafieisabet and Baratitoroqi (2009) emphasized that rural-urban linkage creates, increases, and organizes the sectoral and spatial flows between villages and cities. These flows play a prominent role in forming and expanding weekly markets or commercial centers in urban and rural settlements that influence the spatial aspects and eventually lead to spatial changes in rural settlements. Saeedi (2011) concluded that every spatial system, including rural settlements, is controlled by the internal trends and forces in their environment and is also affected by external parties and movements. Thus, the interaction between the internal and external forces is considered among the rules governing various systems. The internal and external factors and forces significantly influential in forming rural-urban linkage can impact the process of spatial changes in rural settlements around the cities. Shafieisabet (2013) inferred the lack of favorable conditions, such as developing agricultural and non-agricultural activities and reducing job opportunities in rural areas.

On the one hand, the lack of support for small-scale exploiters and farmers can prevent efficient use of the village environment and the abilities and skills of the villagers despite the abundant natural, social, and economic capacities. This subject will damage the motivation to be involved in economic activities in villages and encourage the villagers to migrate out of the village and to cities, eventually reducing the rural population and increasing the urban population. This increased urban population and abandonment of the rural settlements can cause a decline in the sectoral and spatial flows between the rural and urban areas and lead to incompatible effects on the spatial changes of rural settlements. Afrakhteh et al. (2014) concluded that vast rural-urban interactions and linkage as flows of goods, capital, population, information, beliefs, and innovation significantly impact human settlements. Many transformations that emerge in villages and cities can cause changes in rural settlements.

Shafiei Sabet et al. (2016) found that factors such as favorable climate can also influence the rural-urban linkage and thus affect the flow between the rural and urban areas and the economic, social, environmental, and physical-infrastructural aspects since. It can attract a population at both ends of the rural and urban spatial flows, resulting in the flow of people, goods, services, and waste between rural and urban areas. However, this increased population will cause the outflow of people to the nearby lands and villages. It will bring about a change in land use, housing, and even rural housing models. Eventually, it can be inferred that external factors can influence the sectoral and spatial flows, create bonds between rural and urban areas, and influence the transformation of rural settlements. Shafieisabet and Mazarzehi (2019) concluded that rural-urban linkage resulted in sectoral and spatial flows. Thus, many new goods or service supply enterprises settle around urban or rural regions and recreational activities. That is tailored to the middle and urban upper class emerge and becomes one of the essential parts of the economic activities and employment patterns around the outskirts and in the rural areas around the cities. The increasing impacts of cities on land use and land ownership, financial activities, and the labor market in the surrounding rural regions significantly impact the livelihood and agricultural products of those who live in those areas and improve their livelihood. The people, goods, waste flow and the respective capital and information flow are behind the spatial rural-urban linkage. This subject can establish positive cycles of a reciprocal link between the two areas.

The agricultural-industrial linkage can improve villagers' livelihood, prevent them from leaving their homes for cities, and improve the rural-urban linkage. Some argue that the link between rural and urban areas and people and enterprises has intensified over time. The spatial reaction, including the movement of population, goods, information, capital, waste, and social networks that are the foundation for these flows, has to increase tangibly in volume and product.

Shafieisabet and Mirvahedi (2021) found that attention to the rural-urban linkage and compilation of integrated rural-urban policies has contributed significantly to the empowerment of villagers and farmers in various countries. When analyzing the rural-urban linkage in multiple countries, the attention to the capacity of this linkage and empowering farmers are among the essential factors. Farmers will be empowered in various aspects of the rural-urban linkage strengthened, and the spatial flows will be steered through a suitable process accordingly. It can be helpful to establish spatial capacities and enhance them to create direct flows such as production, consumption, financial, or indirect cooperation flows in villages. These flows can increase innovation, education, awareness, and social and economic skills and empower the farmers to access socio-economic development potentials and opportunities. A review of the literature and previous research revealed that sectoral and spatial flows and their impact on rural areas' social, economic, environmental-ecologic, and physical-infrastructural aspects is a question whose answer must be sought in each geographical region. Although rural-urban linkage is among the high-potential socio-economic capacities for spatial changes in rural settlements, many of their capabilities for pastoral planning and change have been overlooked. Thus, analysis and investigation of the ability of rural-urban linkage and conducting deep analyzes on them in line with the spatial flows will contribute significantly to the work of rural and urban planners and facilitate favorable exploitation of these capacities in the studied area. The present study analyzes the capabilities based on the structural equation model and incorporates new indicators and items considering the specification of Damavand County villages based on field observations. It will contribute to the scientific accumulation and the scientific linkage among the researchers referenced in this study and present a new technique to explore this topic in the studied area.

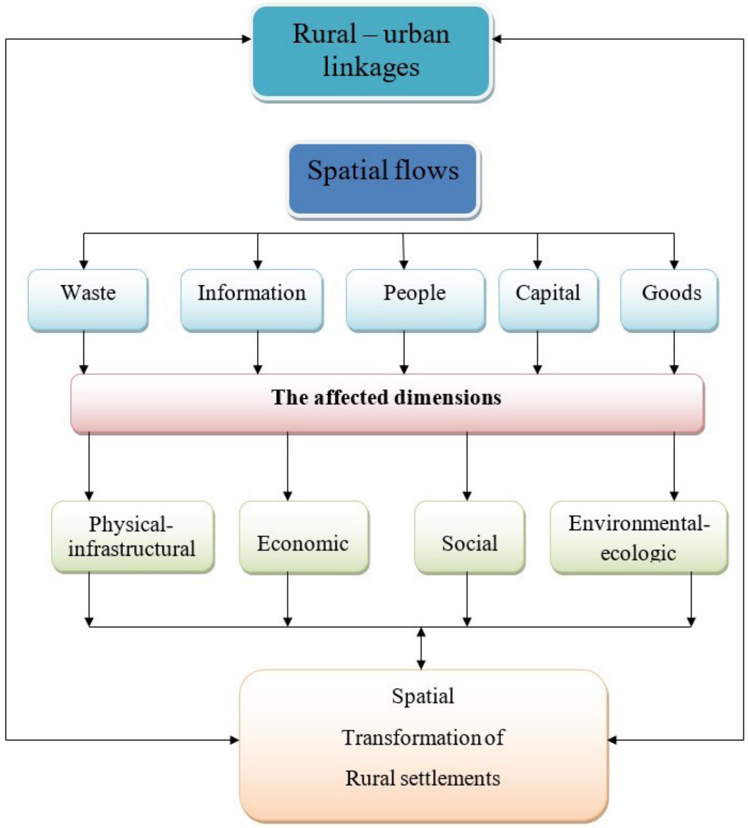

Figure 1. The conceptual framework of the capacity of rural-urban linkage and flows (Source: Literature review, 2021)

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3. Methodology

This study is applied in terms of purpose and descriptive-analytical method. Data collection was performed through field surveys and desk research. A field survey was used to collect data on the indicators, items, and measures influencing the independent variable (the capacity of rural-urban linkage) and the dependent variables (spatial changes in rural settlement). The research population included 83 villages in Damavand County, according to the 2016 census by the Statistics Center of Iran. These villages lived in Markazi and Roudehen districts and five rural districts. Simple randomized sampling was used as the first step to select 30 villages as a random sample based on the central limit theorem considering the homogeneity of the studied area in terms of limitations and facilities (Kothari, 2009). In the second step, Cochran's sample size calculation formula was used to determine the sample size, which estimated a sample size of 370 households on the 95% confidence level with a 5% probability accuracy, 25% variance estimation, and considering the statistical population of 3,901 families in the 29 villages. In the third step, the sample size from each sample village was determined with a normal distribution in proportion to the number of rural households (Table 1), and questionnaires were distributed, completed, and collected in the simple villages.

Table 1. The estimated sample size in the studied villages in the Central District of Damavand County

Rural district	Sample village	Number of households	Sample size
Abarshiveh	Dehnar	91	9
	Yeher	63	6
	Roudafshan	19	5
	Sarbandan	823	63
	Moqanak	37	5
	Aiinevarzan	338	30
Tarroud	Kaldashttaraqi	12	5
	Hesarbala	144	14
	Owzandarreh	8	5
	Mara	359	29
	Khorramdarreh	69	7
	Zerehdar	35	5
Jam Abroud	Louman	117	11
	Vardaneh	90	9
	Boulan	33	5
	Mahmoudieh	10	5
	Vadan	393	30
	Atabak Shams Olya	14	5
Abali	Sadatmahaleh	436	34
	Hezardasht	18	5
	Ardineh	135	13
	Javard	212	20
	Veskareh	130	12
Mehrabad	Golahak	139	13
	Cheshmeha	37	5
	Khourin	37	5
	Abbasabad	27	5
	Noudeh	42	5
	Yalqandarreh	33	5
	Total	3901	370

Source: research findings from the 2016 census of the Iranian statistics center

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Research indices and indicators were identified and analyzed based on a review of the literature, research background, and the studied area's conditions identified through a field survey. Cronbach's alpha was used to determine the reliability of the qualitative questions, which revealed an alpha of 0.893, 0.823, 0.863, and 0.865 for the economic, sociocultural, environmental-ecological, and physical-infrastructural indices, respectively. An alpha of 0.893, 0.888, 0.865, 0.842, and 0.866 was estimated for information and technology, population, goods and services, waste, and capital flows, respectively. Face validity was used to determine the validity of the questions by asking academic experts and specialists at Shahid Beheshti University their opinions on the studied subject. Descriptive statistics were used to analyze the data, and a structural equation model was used to analyze and explain the effects and affected indices (Table 2) and their flows.

Table 2. Influential components, indicators, and items of the study

Index Rural-urban linkage	Items	Scholars
Goods-services flow (K)	Villagers visiting the city to purchase agricultural, livestock, farming, and raw materials for their products(K1)	(Douglass, 1998; Tacoli, 2004; Shafieisabet & Baratitoroqi, 2009; Saeedi, 2011; Shafieisabet, 2013; Afrakhteh et al., 2014; Shafieisabet et al., 2016; Rahmani et al., 2019; Shafieisabet & Mirvahedi, 2021)
	Villagers visiting the city to purchase and access more facilities (K2)	
	Visiting the city to supply agricultural machinery and equipment, toxins, fertilizers, and seeds required for agriculture (K3)	
	Visiting the city to supply raw materials for workshop production units and support facilities and services (K4)	
	Visiting the city for medical and healthcare services (K5)	
	Visiting the city for more cultural and educational services (K6)	
	Visiting the city to supply more food and welfare (K7)	
Capital (S)	urban residents purchasing rural lands (S1)	(Douglass, 1998; Tacoli, 2004; Shafieisabet & Baratitoroqi, 2009; Rahmani et al., 2019; Shafieisabet & Mirvahedi, 2021)
	Urban residents investing in agricultural activities for villagers (S2)	
	Urban residents investing in industrial activities in villagers (S3)	
	Urban residents investing in workshops for villagers (S4)	
	Villagers invest in cities by purchasing houses and stores (S5)	
Population (M)	Villagers referring to cities possess houses on the outskirts (M1)	(Douglass, 1998; Tacoli, 2004; Shafieisabet & Baratitoroqi, 2009; Saeedi, 2011; Shafieisabet et al., 2016; Rahmani et al., 2019; Shafieisabet & Mirvahedi, 2021)
	Urban residents refer to villages and changing the land use in rural areas (M2)	
	Urban residents refer to villages for agriculture and raw material for production (M3)	
	Villagers refer to the city to earn income (M4)	
	Urban residents refer to the village to take advantage of rural services for mass production (M5)	
	Villagers refer to the city to take advantage of better facilities and urban services (M6)	
Waste (P)	The state of rural waste generated through urban industrial activities (P1)	(Douglass, 1998; Tacoli, 2004; Shafieisabet et al., 2016; Rahmani et al., 2019; Shafieisabet & Mirvahedi, 2021)
	The state of the land, water, and soil pollution in villages resulting from urban wastewater (P2)	
	The state of the land, water, and soil resource pollution resulting from the establishment of urban industries around the village (P3)	
Information and technology (A)	The expansion of the virtual space and formation of rural-urban linkage (A1)	(Douglass, 1998; Tacoli, 2004; Shafieisabet & Baratitoroqi, 2009; Saeedi, 2011; Shafieisabet, 2013; Afrakhteh et al., 2014; Shafieisabet et al., 2016; Rahmani et al., 2019; Shafieisabet & Mirvahedi, 2021)
	The expansion of virtual space, agricultural and non-agricultural training, and increased skills of the villagers(A2)	
	The expansion of virtual space and increased information and awareness in social and economic fields (A3)	
	The expansion of virtual space and the formation of network marketing (A4)	
	The expansion of virtual space and the facilitation of agricultural, breeding, industrial, beekeeping, warehousing, marketing and sales, and agricultural and non-agricultural product transportation activities (A5)	
	The expansion of virtual space and easier access to banking and governmental regulations and announcement, and receiving information concerned with the area (A6)	

Source: a review of the literature and research background, and expert opinions (2020)

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Table 3. The affected component, indicators, and items of the study

Dimension Rural settlement changes	Criterion	Items	
Environmental and ecologic (E.C.)	Land resources	Improvement of agricultural land quality and quantity (EC1)	(Douglass, 1998; Tacoli, 2004; Shafieisabet & Baratitoroqi, 2009; Saeedi, 2011; Shafieisabet, 2013; Afrakhteh et al., 2014; Shafieisabet et al., 2016; Rahmani et al., 2019; Shafieisabet & Mirvahedi, 2021)
		Improvement of rangeland quality and quantity (EC2)	
		Improvement of water (aqueduct) quality and quantity (EC3)	
		Improvement of soil quality (EC4)	
		Improvement of horticultural activities in the village (EC5)	
		Agricultural improvement in the village (EC6)	
		The quality and quantity of surface and groundwater (EC7)	
	Environmental hygiene	Transfer of urban wastewater to the village (EC8)	
		Improvement of environmental health in the village (EC9)	
		Improvement of waste collection and reduction the pollution in the villages because of the establishment of urban industries (EC10)	
		Reducing rural pollution due to urban residents (EC11)	
Sociocultural (F)	Social welfare	Improvement of rural social safety (F1)	
		Improvement of artistic and cultural activities (F2)	
		Improvement of social and cultural infrastructures for villages (F3)	
		Improvement of social facilities available to villagers (F4)	
	Quality of life	Higher quality of life because of the opportunities, facilities, and services (F5)	
		Increased employment quality and earning (F6)	
		The physical change of rural housing (F7)	
		Attracting rural population to villages (F8)	
	Migration	The lack of rural migration (F9)	
	Population	The change in population (F10)	
	Institutional infrastructure	Villagers' migration to acquire better welfare (F11)	
	Cooperation	Increasing the cooperation of villagers (cooperation) in rural affairs (F12)	
Economic (E)	Economic welfare and justice	Lack of rural poverty (E1)	
		Increased agricultural and non-agricultural employment (E2)	
		Reducing rural vulnerability (E3)	
		Creating jobs for villagers (E4)	
		Establishment of economic facilities (E5)	
		Increasing tourism (E6)	
		Increasing workshops and handicrafts in the village (E7)	
		Reducing the vulnerability of villagers in agricultural activities (E8)	
		Improvement of the savings account rate in banks (E9)	
		Increasing the income (E10)	
Physical and infrastructural (Z)	Rural Housing	Establishment of engineered housing units (Z1)	
		Housing improvement and reinforcement in villages (Z2)	
		Selling lands for the establishment of housing units (Z3)	
	Access to services	Establishment of welfare services (Z4)	
		Improving access roads in the village (Z5)	
		Establishment of access to markets to sell the products (Z6)	
		Improvement of infrastructural services (water, power, gas) in villages (Z7)	
		Improvement of villagers' access to the internet (Z8)	

Source: a review of the literature and research background, and expert opinions (2020)

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Damavand County is a fertile and green region with the mythical name of the Damavand Mountains. Damavand region is at the intersection between three essential areas of ancient (Rey, Qom, and Tabarestan) and contemporary (Tehran, Mazandaran, and Semnan) Iran, which has increased its importance. This region's unparalleled climatic diversity and balance attract various visitors and migrants to this county every year. Damavand County lives in an area as large as 28000 square kilometers and neighbors Mazandaran province in the north, Firouzkouh in the east, Garmsar and Varamin in the south, and Lavasanant, Shemiran, and Tehran in the west. Damavand is geographically on the Central Mountain range (Alborz Mountains) in the northeastern area of Tehran province.

4. Findings

Out of the 370 questionnaires filled out by the villagers, 49.2% of the respondents were male, and around 50.8% were female. The goat data suggest that 18.6% of the respondents were single, and 78.1% were married. 8.6% of the respondents were literate enough to read and write, 7% had elementary school education, 10.3% had secondary school education, 34% had high school diplomas, 31.4% had a bachelor's degree, and 8.6% had a master's degree. Results also showed that 43.5% of the respondents were younger than 35, 24.5 were in the 36-46 age group, 19.4% were in the 47-57 age group, 9.7% were in the 58-68 age group, 2.1% were over 68 years old.

Examining the normality of variables

Data normality must be examined before any analysis to conduct parametric tests and comments on the data. The null hypothesis is that the data distribution is normal, tested at the 5% confidence level when investigating data normality. Thus, a test statistic equal to or larger than 0.05 would mean that the data is distributed normally. Data normality is examined using the Shapiro-Wilk or the Kolmogorov-Smirnov test. The Kolmogorov-Smirnov (K-S) test compares the statistical sample's density distribution to a specific value, considering the observed frequency distribution.

Once data normality is confirmed, parametric tests such as variance analysis, mean comparison, regression, and correlation can examine the state of the variables. The linkages between the research variables based on the proposed hypotheses are examined accordingly.

Evaluation of the influence of total flows on the entire spatial changes

Table 5.12 indicates the linkage between the flows and the entire dimensions. The Kendall-tub test showed a significant linkage between total flows and dimensions in the studied villages, with a correlation coefficient of 0.291 and a significance level of 0.000. This linkage was positive and significant at the 0.05 level. The confidence level of this linkage is approximately 95%. The intensity of the linkage between these variables turned out to be moderate.

Table 4. The Kolmogorov-Smirnov (K-S) test of the flows

Flows	Goods flow	Capital flow	Population flow	Information flow	Waste flow	Total flow
Mean	3.97	3.91	3.96	4.39	3.69	3.78
Z	0.003	0.000	0.001	0.004	0.005	0.000
Sig.	0.000	0.000	0.000	0.000	0.000	0.000

Source: Research findings

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Table 5. The Kolmogorov-Smirnov (K-S) test of the dimensions

Dimensions	Economic	Sociocultural	Environmental-ecologic	Service-infrastructural	Total dimensions
Mean	3.87	3.88	3.89	4	3.91
Z	0.000	0.004	0.001	0.000	0.002
Sig.	0.000	0.000	0.000	0.000	0.000

Source: Research findings

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Table 6. The Kolmogorov-Smirnov (K-S) test of the variables

Variables	Population	Housing	Land use	Investment
Mean	4	3.60	3.78	4
Z	0.001	0.000	0.004	0.003
Sig.	0.000	0.000	0.000	0.000

Source: Research findings

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Table 7. The linkage between the flows and total dimensions

Flow	Dimension	the Kendall-tub test		Linkage
		Significance level	Correlation coefficient	
Total flows	Total dimensions	0.000	0.291	Confirmed

Source: Research findings

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The structural equations model

Structural equation modeling is used in studies seeking a specific model of linkages between the variables. The P.L.S. path modeling is among the structural equation modeling techniques. A complete P.L.S. path model includes the two parts of measurement (the external model) and structural. The measurement section investigates the linkage between the questions and the studied items, while the structural section compares the studied factors to test the hypotheses. Given the data distribution normality and the confirmation of the required correlation between the variables, structural equation models (Smart P.L.S. software) can be used in the present study.

Model evaluation

Two models are tested in P.L.S. models, the external model, which is equivalent to the measurement model, and the internal model, which is equal to the structural model in structural equation modeling. The internal model indicates the factor loads of the observed variables.

Examining the reliability of the measurement model: The measurement or the item's model of P.L.S. models is divided into two groups of reflective and composite objects. All the measurement models in the present study are reflective. The one-dimensionality of the criteria must be confirmed, which is tested using Cronbach's alpha to examine these models' reliability. Internal consistency reliability is usually the first criterion discussed in reflective measurement models, traditionally controlled using Cronbach's alpha, which estimates reliability based on the inner correlation between the items. A Cronbach's alpha larger than 0.7 confirms the one-dimensionality and consistency of the criteria (Azar et al., 2011). Aside from Cronbach's alpha, P.L.S. path models use composite reliability to examine the criteria' reliability of one-dimensionality and consistency. The composite reliability of the model has been confirmed if this index is higher than 0.7. Composite reliability is a better criterion to test the one-dimensionality of the criteria than Cronbach's alpha since Cronbach's alpha is based on the assumption that the observed variables are equivalent, suggesting that all the observed variables are of the same importance compared to the latent variables.

In contrast, composite reliability has no such assumption and is based on the model's results (i.e., factors loads) rather than the correlation between the variables observed across data. Cronbach's alpha estimates the lower reliability limit (Azar et al., 2012). That shows the results of P.L.S. software for these two indices.

As observed, the values for the two indices of composite reliability and Cronbach's alpha were higher than 0.7 for the study's axial variables, demonstrating the research variables' good reliability. Thus, the measurement models have good overall reliability. These indices calculate reliability based on the agents' internal correlation or the factor loads. However, since the agents vary in reliability, the reliability of each agent should also be tested separately. Researchers believe that a latent variable must explain a significant portion of the agent's dispersion (at least 50%). Hence, the absolute value of the correlation between an item and each of its observed variables (the total value of standardized output loads) must be over 0.7. Some researchers believe that the variables with factor loads (the correlation between an item and each of its observed variables) smaller than 0.4 must be removed from the measurement model (Azar et al., 2012). Bido believes that the agents with factor loads smaller than 0.7 can be released from the model if the number of agents is small (three to four agents) and the value of AVE is more significant than 0.5 for an item. Some also believe that the weaker agents can be eliminated from the model even if the number of agents is more important than five (Azar, 2012; Ebdali, 2017). The following indicates the reliability of the agents. It would be better to eliminate the variables with factor loads lower than 0.6 from the model.

Testing the validity of the measurement models: Convergent validity is the first measure used to confirm the validity of the measurement models. Convergent validity examines whether the set of agents determines the main item. For this purpose, Fornell and Lacker (1981) suggest using the Average Variance Extracted (AVE). A minimum AVE of 0.5 indicates an adequate convergence, which means a latent variable can explain half of the scatter of its reagents on average (Azar et al., 2012).

Considering that the AVE value for the latent variables is higher than 0.5, it can be inferred that the measurement models have good convergent validity.

Discriminant or divergent validity–a complementary criterion- is the second type of validity investigated to confirm the validity of the measurement model. The two measures of Fornell-Lacker and cross-loadings are used in P.L.S. path modeling to examine the discriminant validity. The present study used the Fornell-Lacker test, which looks for validity at the agent level. This test investigates whether the agent of each item has a higher correlation with the object than the other things (Azar et al., 2012). Table 10 demonstrates the results of the Fornell-Lacker factor loadings. As observed, the loading of each reflective agent for each item is higher than its loading for other agents (the factor loadings of the main diagonal are higher than others). Discriminant validity is thus confirmed.

Table 8. Testing the reliability of the measurement model

Variables	Composite reliability	Cronbach's alpha
Economic	0.809	0.823
Environmental-ecologic	0.873	0.884
Socio-cultural	0.893	0.888
Service-infrastructural	0.812	0.841
Population	0.732	0.786
Information-technology	0.881	0.819
Goods-services	0.942	0.848
Waste	0.767	0.759
Capital	0.901	0.857

Source: Research findings

Table 9. Testing the convergent validity of the measurement model

Variables	AVE
Economic	0.889
Environmental-ecologic	0.720
Socio-cultural	0.818
Service-infrastructural	0.745
Population	0.742
Information-technology	0.764
Goods-services	0.890
Waste	0.981
Capital	0.764

Source: Research findings

Table 10. Testing the discriminant validity of the measurement model

	Economic	Environmental	Social	Infrastruc-tural	Popula-tion	Informa-tion	Goods	Waste	Capital
Economic	0.82								
Environmental-ecologic	0.95	0.88							
Socio-cultural	0.84	0.71	0.88						
Service-infra-structural	0.86	0.88	0.91	0.84					
Population	0.74	0.79	0.93	0.94	0.78				
Information-technology	0.84	0.73	0.74	0.94	0.94	0.81			
Goods-services	0.96	0.79	0.85	0.75	0.96	0.97	0.84		
Waste	0.93	0.78	0.81	0.88	0.97	0.93	0.86	0.75	
Capital	0.76	0.91	0.92	0.84	0.75	0.88	0.74	0.87	0.85

Source: Research findings

JSRD

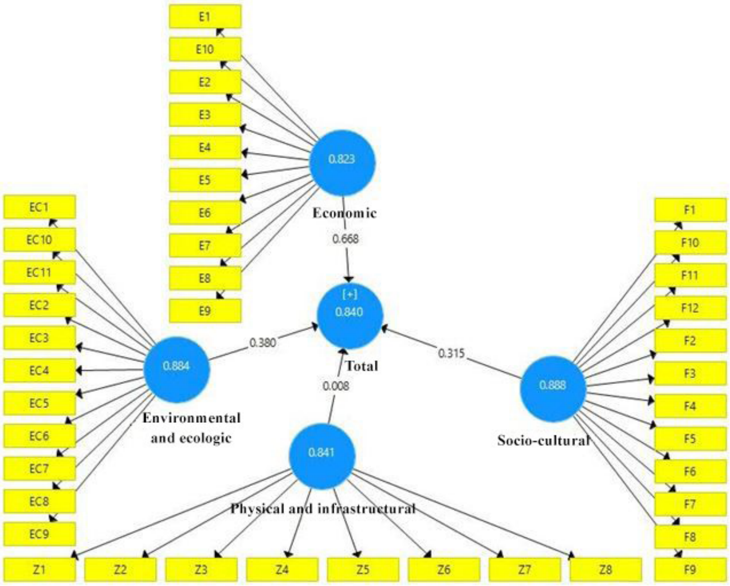

Figure 2. Divergent validity of the spatial dimension indices

JSRD

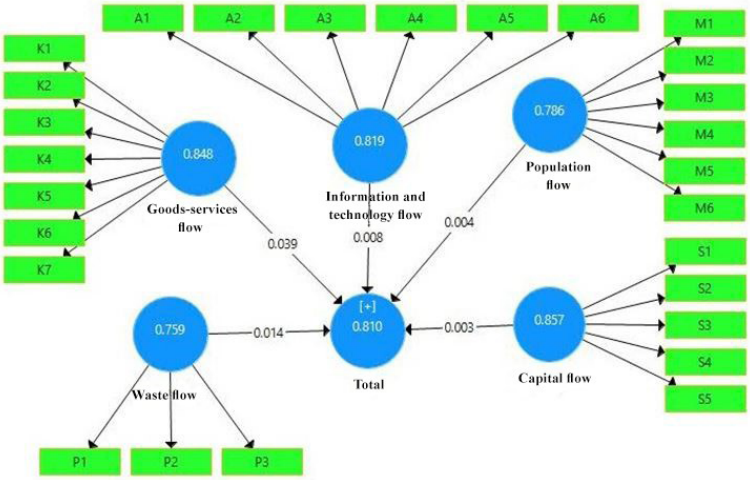

Figure 3. Divergent validity of the flows

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Testing the internal research model

After testing the external research model and confirming its reliability and validity (the measurement research models), the research's internal or structural model should also be examined. The internal model helps examine research hypotheses. The criteria of the t statistic, coefficient of determination, and path coefficient are used to evaluate the model. The numbers on the paths between the items are called the coefficients of the way. Demonstrates the standardized beta in regression or the correlation coefficient between the two things and is used to determine one variable's direct impact on the other. The numbers on the paths between the agents and items in the reflective show the factor loadings. The larger the coefficient of determination is, the better the regression line can associate the dependent variable's changes with the independent variable's changes. The mean R2 is acceptable if the structures of a specific internal path model explain an indigenous latent variable with a limited number (one or two) of exogenous latent variables. However, if the endogenous latent variable depends on several exogenous variables, the minimum R2 value must be at the minimum significant level (over 0.67). Otherwise, doubts regarding the theoretical basis of the model would be raised, and the model would be incapable of explaining the endogenous latent variables (Azar et al., 2012). The R2 value calculated is at the desired level for indecent or exogenous latent variables.

Fitness of the model

The Q2 index can investigate the fitness of the measurement and structural equation models of P.L.S.analyzes. This index is divided into redundancy and communality indices, the positive values of which indicate the good quality of the measurement and structural equation models, respectively. The Positive Goodness of Fit (G.O.F.) index shows the model's overall fitness. Table 12 demonstrates the indices of model fitness. The positive values of the commonality and redundancy indices and three values of 0.01, 0.25, and 0.36 as poor, moderate, and strong G.O.F. values (Ebdali, 2017) show that the model is a good fit since it got a G.O.T. of 0.5.

Table 11. The coefficient of determination for research variables

Variables	Economic	Environmental-ecologic	Socio-cultural	Service-infrastructural	Population	Information-technology	Goods-services	Waste	Capital
R2	0.67	0.90	0.92	0.72	0.68	0.73	0.69	0.93	0.88

Source: Research findings

JSRD

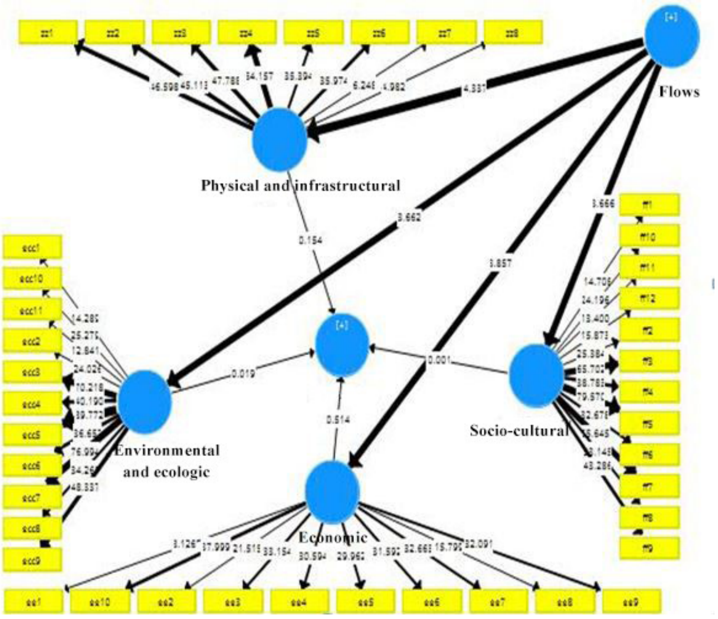

Figure 4. The measurement model of the study in the standard state

JSRD

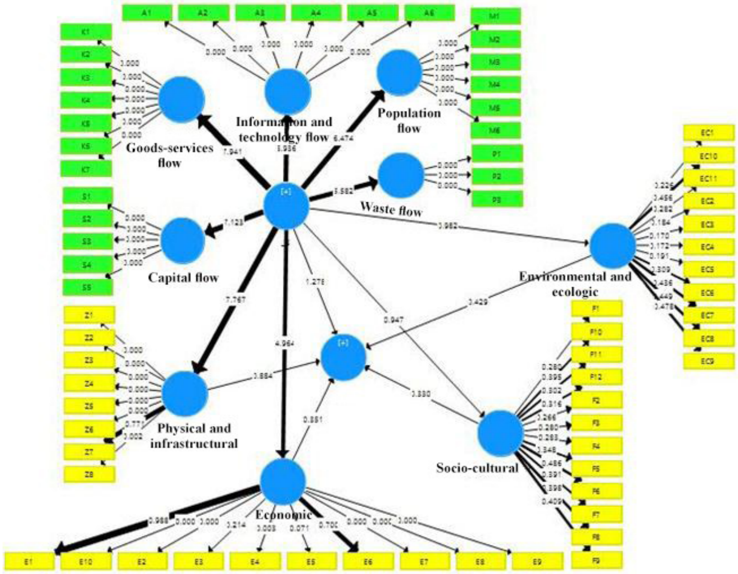

Figure 5. The measurement model of the study in the significance of state

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Table 12. Model fitness indices

Variables	Redundancy index CV-Red	Communality index CV- Com		GOF
Economic	0.00	0.205	0.00	
Environmental-ecologic	0.00	0.435	0.00	
Socio-cultural	0.00	0.493	0.00	
Service-infrastructural	0.00	0.214	0.00	
Population	0.00	0.096	0.00	0.50
Information-technology	0.00	0.088	0.00	
Goods-services	0.00	0.011	0.00	
Waste	0.00	0.532	0.00	
Capital	0.00	0.296	0.00	

Source: Research findings

JSRD

5. Discussion

Results of reviewing the literature and previous research indicated that rural-urban linkage had socio-economic and physical-infrastructural capacities that create spatial flows such as the flows of population, goods and services, information and technology, capital, and waste between urban and rural areas (Douglass, 1998; Tacoli, 2003; Shafieisabet & Azhariyanfar, 2017; Tacoli, 2004; Muloi et al., 2022). these flows lead to spatial changes in rural settlements in sociocultural, economic, environmental-ecologic, and physical-infrastructural dimensions (Shafieisabet & Baratitoroqi, 2009; Saeedi, 2011; Shafieisabet, 2013; Afrakhteh et al., 2014; Shafieisabet, Dosti, Ghorbani, 2016; Rahmani, ShafieiSabet, & Mazarzehi, 2019; Shafieisabet & Mirvahedi, 2021). Therefore, the rural-urban linkage is essential for life in rural and urban settlements. As mentioned in previous research, there is a consensus that proper and compatible rural-urban linkage will lead to the emergence of spatial flows that will eventually transform rural settlements. Results of the present study indicated that rural-urban linkage in the rural settlements of the studied area influenced the spatial changes of the villages through their population, land use, housing, and investment in villages, which is consistent with the results of Shafieisabet and Baratitoroqi (2009), Saeedi (2011), Shafieisabet (2013), and Rahmani, Shafieisabet and Mazarzehi (2017).

Results of the P.L.S. test in ranking the linkage indicated that the service-infrastructure dimension ranked first (3.06) in terms of importance, followed by the environmental-ecologic (2.48), sociocultural (2.39), and economic (2.07) dimensions, respectively. The influence of spatial flows on the dimensions of rural transformation was ranked: the flow of population ranked first (66.6%) in terms of impact on rural settlement transformation, followed by information technology (35.1%), waste (29%), capital (13.3%) and goods-services (1.8%) flows, respectively. However, a positive and significant linkage was observed between the total spatial flows, including population, goods, services, information, and investment, and the spatial changes of rural settlements. The more substantial influence of population flows between the cities and villages in the studied area stemmed from the tourism flows and the daily commute of villagers and city and urban tourists to the rural areas. Improving the urban investment flow in the area's villages would contribute. The flow of goods and services since the villages in Damavand County can take more advantage of the capacities of rural-urban linkage and provide the grounds for improved goods and service flows and better utilization of urban capitals given their high tourism potentials and large horticultural, animal breeding, aquaculture, and agricultural areas. This subject will expand the grounds for employment, increase income, and attract more investment and population, leading to compatible spatial-physical changes in the area.

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Conflict of Interest

The authors declared no conflicts of interest.

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