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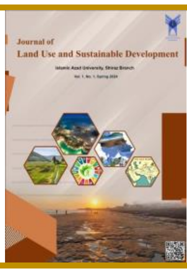

Original Research Paper

Spatial Analysis of Global Innovation Indicators in Selected Countries with Emphasis on Iran

Vahid Boustan Ahmadi*: PhD Graduate in Geography and Urban Planning, Payame Noor University, Tehran, Iran

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Abstract

Innovation is a central driver of competitiveness at both institutional and national levels and serves as one of the key stimuli for production. It plays a vital role for countries aiming to enhance their economic growth and prosperity. In this context, the assessment of innovation has become a prominent topic in scientometric studies in recent years. The need to consider existing international concepts and indicators, along with the necessity of adopting the most appropriate approach to understand a country's real position at the global level, are among the main reasons highlighting its importance. Accordingly, the present study aims to measure and analyze the spatial distribution patterns of global innovation indicators in selected countries, with a focus on Iran, during the period from 2015 to 2018. The research employs a combination of descriptive and analytical methods and is applied in nature. For data analysis, models such as Shannon Entropy, TOPSIS, Coefficient of Variation (C.V), Global Moran's Spatial Autocorrelation, and ArcGIS software were used. The results of the study revealed that among the selected countries, the United Arab Emirates, Saudi Arabia, and Turkey ranked first to third with the highest TOPSIS scores of 0.861, 0.695, and 0.690, respectively. Iran, with a score of 0.630, was ranked fifth, while Yemen, with the lowest score of 0.028, was ranked last. Further findings using the Coefficient of Variation model indicated that among the studied components, the highest inequality was observed in the Business Sophistication component (0.6652), and the lowest was in the Institutions and Higher Education & Human Capital components (0.488). Finally, the spatial distribution pattern among the selected countries was found to be random and unplanned across all components, except for the infrastructure component.

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*Corresponding author: vahid Bostan Ahmadi Email: vahid.ahmadii.1979@gmail.com Tel: +989120273632

Introduction

The world today is a world of innovations, and the growing competition and survival motives among countries at all levels have led development processes to focus their activities on core capabilities and outputs (Haji Hosseini and Sadeghian, 2015). In today's dynamic and transforming world, innovation is regarded as the most fundamental driver of progress in industrial and economic domains, and a country's economy flourishes when the necessary groundwork for innovation and participation in global competitive markets is provided (Salami *et al.*, 2017).

The significance of innovation has attracted the attention of policymakers and decision-makers in recent years (Khani and Nasrollahi, 2017), and many countries are striving to enhance their national innovation capacity to achieve future economic growth and performance goals (Sohn *et al.*, 2014). According to Gerstenfeld and Wortzel (1997), one of the key requirements for economic and industrial development in developing countries is their ability to innovate successfully. Toffler also emphasized that a company must innovate or perish; innovation is a fundamental process for an organization's survival and health (Toffler, 1992). Companies are increasingly concerned about their innovation capabilities (Fagerberg, 2013), and policymakers worldwide are promoting public investments and policies to expand national innovative capacities in order to maintain their positions in the global competitive market (Xi and Prey, 2012).

Today, both developed and developing countries have realized the importance of innovation and its role in enhancing indicators such as employment growth, sustainable development, social transformation, and social welfare (Erkisi and Ulan, 2016). Understanding the factors influencing national innovation levels has become critical, as directing national investments toward these factors can help elevate innovation performance. On the other hand, with the onset of the third millennium—the era of knowledge—and the widespread exchange of ideas and products, along with the role of creativity and innovation in various industries, the protection of intellectual property rights at national and international levels is now imperative. A strong intellectual property regime is therefore an essential tool for economic development (Khani and Nasrollahi, 2017).

In this regard, innovation measurement has emerged as a significant topic in scientometric studies in recent years. The need to consider existing international concepts and indicators, and to adopt the most appropriate approach to identify a country's actual standing in this domain at the global level, are among the primary reasons for the importance of this subject (Kianpour and Salehi, 2015). Innovation is a key factor in the successful development of a country and serves as the main driver of economic growth, enabling greater productivity and a higher quality of life (Zarei, 2018).

Indeed, innovation is the axis of competition at both institutional and national levels and is a fundamental stimulus for production. It is also defined as the process of fully utilizing ideas or transforming them into profitable products, methods, services, or business activities. To stay competitive, producers must go beyond simply offering cheaper and better products and services than their rivals; they must enhance capabilities, improve performance, and reduce costs. Thus, it is beyond doubt that our country must embrace innovation to remain competitive with global economic powers. However, there is little indication that the country's industries, in general, have adopted such a perspective (Vahedian, 2008).

Innovation, therefore, breathes life into a knowledge-based economy. It can pave the way for sustainable development, and if Iran intends to maintain its future position in global markets, it must introduce non-oil products into its economic cycle. This requires a dynamic and innovative mindset, and innovation will act as a prerequisite for economic vitality and stability (Salami et al., 2017). In an era marked by rapid technological change, innovation is considered one of the most important factors driving productivity and economic growth in countries, and today, a nation's sustainability in global competition depends largely on its level of innovation (Haji-Hosseini and Sadeghian, 2016).

A review of previous Global Innovation Index reports from 2011 to 2014 reveals that Iran not only failed to maintain or improve its position but dropped from rank 95 in 2011 to 120 in 2014 (Zein-al-Abedini, 2015). In this context, Iran must enhance its global innovation performance to stimulate economic growth and improve productivity. Analyzing global innovation indicators for Iran and comparing annual innovation rankings of countries worldwide and in the region will reveal the country's strengths, capacities, and potentials, as well as its weaknesses and challenges in different sectors. Moreover, the calculation of these indicators enables comparison between Iran and regional countries, as well as with the targets of Iran's Vision Plan for 2025 and other countries around the world, across all dimensions of innovation.

Monitoring and ranking the country within the Global Innovation Index can serve as a basis for comprehensive and multidimensional studies aimed at improving Iran's innovation landscape and guiding national innovation policies. Accordingly, this research aims to evaluate the status and analyze the spatial distribution pattern of global innovation input and output indicators, focusing on Iran's position among selected Asian countries in the region. Based on this objective, the following research question is addressed:

What is Iran's position in terms of innovation indicators among the selected countries?

Literature Review

Innovation is defined as the adoption of an idea, behavior, system, policy, program, tool, process, product, or service that is new to the organization (Damanpour, 1992). In other words, any product or service introduced for the first time in technological or other fields that generates revenue is considered an innovation (Gibson and Naquin, 2011). Innovation is understood as the key driving force of economic growth through the creation, diffusion, and eventual use of knowledge (Jankowska *et al.*, 2017). Moreover, innovation results from complex interactions among actors with complementary competencies (technological, managerial, financial, or regulatory) operating under specific institutional frameworks (Bins and Trover, 2017).

The term innovation is generally defined in two ways: (1) the introduction of a new idea, or (2) a new idea, method, or device (Webster, 2017). Innovation can be categorized into two main types: technological and organizational innovation (Phillips, 1997). Hult defines innovation as a process of applying knowledge or information in order to create or introduce something new and useful (Hult, 1998). According to Warkins, "Innovation is anything revised that is designed and realized to strengthen an organization's position against its competitors and to provide sustainable competitive advantage over time. In other words, innovation is the creation of a new idea that follows a specific purpose and is ultimately implemented" (Warkins, 1990).

The Oslo Manual by the Organisation for Economic Co-operation and Development (OECD) defines innovation as the implementation of a new or significantly improved product (good or service), a new process, a new marketing method in business practices, workplace organization, or external relations (Crespo, 2016).

As early as 1939, Bernal pointed out that initial models developed to explain innovation were linear in nature, emphasizing the accumulation of scientific knowledge as the main driver of technological development and the primary cause of innovation (Bitaab *et al.*, 2013). In this context, science-push was regarded as the driving force behind innovation (Bernal, 1939). Freeman (1987), while criticizing the linear model, proposed the "interactive chain-link" model, emphasizing the non-linear nature of innovation and recognizing demand-pull alongside science/technology-push as key drivers of innovation (Kline and Rosenberg, 1986; Freeman, 1987; von Hippel, 1998).

A systems-oriented perspective on innovation and its determinants emerged in the early 1990s through the work of scholars in science, technology, and innovation policy, such as Freeman (1995), Lundvall (1992), and Nelson (1993). This led to the formation of the National Innovation System (NIS) theory (Hajihosseini & Sadeghian, 2016). Subsequently, innovation scholars like Etzkowitz sought to identify the complex mechanisms through which knowledge generated in universities could be transferred to industrial firms and enhance their capabilities—leading to the emergence of the "university-industry relationship" discourse (Etzkowitz, 1994).

The evolution of innovation models at the national level has enhanced the understanding of scientists and policymakers about innovation processes and mechanisms. Additionally, models for assessing national innovation capacity have been developed, mostly focusing on quantitatively measuring innovation and its influencing factors, thereby enabling cross-country comparisons.

Global Innovation Index (GII)

In recent years, various models, reports, and indices have been proposed to identify the factors influencing innovation at the national level. One of the most reputable is the Global Innovation Index (GII). This index recognizes innovation as a crucial driver of economic growth and national prosperity. Its purpose is to capture the multifaceted aspects of innovation and to ensure applicability across both developed and emerging economies (Moradi *et al.*, 2018).

The GII, developed through collaboration between the World Intellectual Property Organization (WIPO), the Institute for Management Development, and since 2013, Cornell University, provides a comprehensive and rich dataset for comparing innovation performance and identifying innovation trends at both national and global levels (Jankowska *et al.*, 2017). The GII comprises 7 main pillars and 81 indicators, divided into two major sub-indices: Innovation Input and Innovation Output.

The Innovation Input Sub-Index includes five components: Institutions, Human Capital and Research, Infrastructure, Market Sophistication, and Business Sophistication, each scored on a scale from 0 to 100. The Innovation Output Sub-Index consists of two components: Knowledge and Technology Outputs, and Creative Outputs. The GII score is calculated as the simple average of the input and output sub-indices. Additionally, the Innovation Efficiency Ratio is derived from the ratio of the output sub-index to the input sub-index.

Numerous studies have been conducted around the world on the topic of this article, each approaching it from a specific perspective. This section provides a summary of several international and Iranian studies that are more closely related to the subject.

Crespo (2016) presents a study titled "A Fuzzy Qualitative Comparative Analysis for the Global Innovation Index." In this study, countries with high and low income levels are examined. The research indicates that a country can achieve high innovation capacity through the combination of multiple conditions. Moreover, it suggests that for low-income countries, multiple and diverse pathways are necessary to enhance innovative performance, while in high-income countries, infrastructure, human capital, and research conditions alone are sufficient to improve innovation outcomes.

Souhno *et al.* (2014), conducted a study titled *"Evaluation of the Global Innovation Index Based on a Structural Equation Model."* This study proposes a structural equation model based on the national innovation system, incorporating seven factors that represent inputs (institutions, human capital, research, infrastructure, market sophistication, and business sophistication) and outputs (knowledge outputs and creative outputs). Using Global Innovation Index data from 2013, the study finds that business sophistication and infrastructure have direct and indirect impacts on creative production, respectively.

Bagheri Nejad (2006), in an article titled *"Exploitation of Technological Innovations in Middle Eastern Countries,"* aims to present findings on the technological innovation process and industrial characteristics in developing countries, including Iran.

Moradi *et al*. (2018), in the article *"The Impact of Human Capital on Innovation: A Comparative Study of Developing and Developed Countries,"* examine the influence of human capital on innovation. Using World Bank data and the Global Innovation Index, 113 countries were analyzed across four income categories (low, lower-middle, upper-middle, and high). The findings reveal that along the development path (from lower to higher income levels), attention to skills and education of human resources should be aligned with each country's status.

Salami *et al*. (2017), in the article *"Investigating the Internal Relationship Between Input and Output Dimensions of the Global Innovation Index for Achieving a Knowledge-Based Economy,"* aim to improve innovation levels and, consequently, the level of knowledge-based economy. Using global statistics in the field of innovation and knowledge economy, the study first identifies key input indicators affecting innovation and then compares these indicators with global averages. After identifying weaknesses in input metrics, their status is evaluated in Iran's Sixth Development Plan.

Khani and Nasrollahi (2017), examine *"The Role of Factors Influencing Innovation in*

Developed and Developing Countries." The objective is to explore the relationship between innovation and the Intellectual Property Rights Index along with other influential factors. Using panel data, the study investigates the effect of intellectual property protection, changes in per capita GDP, savings rate, real interest rate, and human capital on innovation between 2007 and 2014.

Kianpour and Salehi (2015), in a study titled "Measuring the Technology Achievement and Innovation Index in Iran Compared to Other Countries," aim to introduce the Global Innovation Index and the Technology Achievement Index (TAI) and assess Iran's status in these indices. The findings show that activities related to technological development and innovation are considered main drivers of economic growth. Moreover, past Global Innovation Index reports indicate that Iran has not been able to maintain or improve its position in this area.

In reviewing the literature on global innovation, it becomes evident that the scope of related research in Iran is relatively limited. Most existing studies have focused on developing models to evaluate the national position and identify the strengths and weaknesses of the country in terms of global innovation indicators. Furthermore, the review of prior research strengthens the hypothesis that there is a clear lack of studies on the model and spatial distribution of Global Innovation Index indicators in West Asian countries, especially with an emphasis on Iran.

The Area under Study

Since the mid-20th century, Central and Western Asia has been the focus of global attention and arguably the most strategically, economically, politically, and culturally sensitive region in the world. This area possesses some of the largest oil reserves and hosts a wide range of ethnic and cultural groups, including Iranian, Arab, Berber, Turkic, Azeri, Kurdish, Jewish, and Assyrian cultures.

The statistical population of this study consists of 18 countries, namely: Saudi Arabia, the United Arab Emirates, Qatar, Oman, Bahrain, Yemen, Iran, Jordan, Egypt, Turkey, Turkmenistan, Tajikistan, Kazakhstan, Kyrgyzstan, Azerbaijan, Armenia, and Pakistan. In 2018, these countries collectively accounted for a population of 611,627,701 people worldwide. Among them, Pakistan, with a population of 200,813,818, was the most populous, while Bahrain, with 1,566,993 people, had the smallest population. Iran, with a population of 82,011,735, was the second most populous country in the studied region.

Methodology

This study is applied in terms of its objective and follows a descriptive-analytical methodology. The geographical scope of the research includes 18 selected countries from Central and Western Asia, based on the 2018 report of the International Institute for Management Development (INSEAD). The data collection tool focuses on analyzing the spatial distribution of global innovation indicators through seven main components. These data were obtained from the Global Innovation Index (GII) Report. For data analysis, various models have been employed, including Shannon Entropy, the TOPSIS multi-criteria decision-making technique, the Coefficient of Variation (C.V.) model, the Global Moran's I spatial autocorrelation method, and ArcGIS software.

Indicators studied: The selected indicators are based on the two main sub-indices of the Global Innovation Index, namely "Innovation Input Indicators" and "Innovation Output Indicators." The input indicators include institutions, human capital and research, infrastructure, market sophistication, and business sophistication. The output indicators include knowledge and technology outputs, as well as creative outputs (Global Innovation Index Report, 2018). (Table 1).

Table 1. Global Innovation Indicators Used in the Study

Country	Institutions	Human Capital & Research	Infrastructure	Market Sophistication	Business Sophistication	Knowledge & Tech Outputs	Creative Outputs
United Arab Emirates	77.8	45.6	57.4	54.4	47.9	25.7	31.1
Jordan	60.6	31.0	40.4	36.2	18.7	18.6	29.8
Iran	48.3	36.7	38.3	38.3	21.9	30.8	29.5
Bahrain	50.7	27.6	54.1	46.1	26.7	20.8	24.0
Saudi Arabia	51.9	47.7	49.4	51.7	33.0	20.2	23.4
Oman	62.1	40.3	48.3	44.9	21.5	16.3	28.1
Qatar	67.9	35.7	58.0	44.3	27.2	23.6	29.3
Turkey	51.0	35.8	49.3	48.4	28.7	25.7	38.7
Lebanon	49.4	26.6	38.5	44.5	29.7	14.3	23.1
Egypt	44.3	23.0	37.9	38.8	19.5	21.1	22.1
Yemen	28.7	13.7	21.2	31.6	15.7	5.6	10.2
Armenia	60.8	15.2	36.5	43.5	26.1	23.5	35.0
Georgia	71.7	30.0	42.5	52.5	25.7	24.5	26.8
Kazakhstan	66.2	29.1	45.4	49.1	27.5	19.9	18.7
Kyrgyzstan	50.7	29.9	36.0	46.1	27.3	19.5	14.8
Pakistan	44.0	12.2	26.9	38.1	24.0	20.4	18.0
Tajikistan	44.9	24.3	21.3	51.4	23.2	20.1	19.9
Azerbaijan	58.9	18.4	44.3	55.4	24.8	17.1	22.9

Source: Report on Global Innovation Index (GII), 2018

Results and Discussion

Analysis Using the TOPSIS Multi-Criteria Decision-Making Method

As mentioned earlier, the TOPSIS method has been used to prioritize and determine the position of each of the studied countries in terms of global innovation indicators. This method, which is categorized under compensatory models (models in which trade-offs between indicators are significant) and is a subset of compromise models (in which the preferred option is the one closest to the ideal solution), has been applied (Asgharpoor, 2008).

Table 2. Ranking of West Asian Countries Based on Global Innovation Indicators Using the TOPSIS Technique

Countries	Institutions (CLI)	Rank	Capital & Human Research (CLI)	Rank	Infrastructure (CLI)	Rank	Market Complexity (CLI)	Rank	Business Complexity (CLI)	Rank	Knowledge & Technology Outputs (CLI)	Rank	Creative Outputs (CLI)	Rank	Overall (CLI)	Rank
Azerbaijan	0.6151	8	0.1747	15	0.6304	8	1	1	0.2826	11	0.4565	15	0.446	12	0.351	16
Armenia	0.6538	6	0.0845	16	0.4158	14	0.5	13	0.3230	9	0.7103	6	0.87	2	0.429	12
Iran	0.3992	14	0.6901	4	0.4647	12	0.2815	15	0.1926	14	1	1	0.677	5	0.63	5
Jordan	0.6497	7	0.5296	7	0.5217	10	0.1933	17	0.0932	17	0.5159	14	0.688	4	0.508	8
UAE	1	1	0.9409	2	0.9837	2	0.9580	2	1	1	0.7976	2	0.733	3	0.861	1
Bahrain	0.4481	11	0.4338	11	0.8940	3	0.6092	8	0.3416	8	0.6032	8	0.484	9	0.497	9
Turkey	0.4542	10	0.6648	5	0.7636	5	0.7059	7	0.4037	4	0.7976	2	1	1	0.69	3
Pakistan	0.3116	17	0	18	0.1549	16	0.2731	16	0.2578	12	0.5873	9	0.274	16	0.261	17
Tajikistan	0.3299	15	0.3409	13	0.0027	17	0.8319	5	0.2329	13	0.5754	11	0.34	14	0.357	15
Kazakhstan	0.7638	4	0.4761	10	0.6576	7	0.7605	6	0.3665	5	0.5675	12	0.298	15	0.474	10
Kyrgyzstan	0.4481	11	0.4986	9	0.4022	15	0.6092	8	0.3603	6	0.5516	13	0.161	17	0.43	11
Qatar	0.7984	3	0.6620	6	1	1	0.5336	12	0.3571	7	0.7143	5	0.67	6	0.654	4
Georgia	0.8758	2	0.5014	8	0.5788	9	0.8782	3	0.3106	10	0.75	4	0.582	8	0.552	7
Saudi Arabia	0.4725	9	1	1	0.7663	4	0.8445	4	0.5373	2	0.5794	10	0.463	10	0.695	2
Oman	0.6802	5	0.7916	3	0.7364	6	0.5588	10	0.1801	15	0.4246	16	0.628	7	0.605	6
Lebanon	0.4216	13	0.4056	12	0.4701	11	0.5420	11	0.4348	3	0.3452	17	0.453	11	0.413	13
Egypt	0.3177	16	0.3042	14	0.4538	13	0.3025	14	0.1180	16	0.6151	7	0.418	13	0.379	14
Yemen	0	18	0.0423	17	0	18	0	18	0	18	0	18	0	18	0.028	18

In this section, after forming the decision matrix, weighting, and other structural components of this model, the results of the ranking of the regional countries are presented separately according to the seven innovation components and the overall innovation score as shown in Table 2 and below.

Global Innovation Input Components

Institutions Component: In this component, the United Arab Emirates ranks first with the highest TOPSIS score (1), while Yemen ranks last with the lowest TOPSIS score (0). Georgia holds the second position with a TOPSIS score of 0.8758. Iran, with a TOPSIS score of 0.3992 in this component, ranks fourteenth, which indicates an unfavorable condition compared to the other seven innovation components.

Capital and Human Research Component: Regarding this component, Saudi Arabia, with a TOPSIS score of 1, the UAE with 0.9409, and Oman with 0.7916, have secured the first to third positions respectively. Iran ranks fourth with a TOPSIS score of 0.6901 in this component, which reflects a favorable status compared to the other seven innovation components.

Infrastructure Component: In this component, Qatar ranks first with a TOPSIS score of 1, followed by the UAE with 0.9837 and Bahrain with 0.8940 in second and third places, respectively. Iran ranks twelfth with a TOPSIS score of 0.4648, indicating an unfavorable position.

Market Complexity Component: Azerbaijan ranks first with a TOPSIS score of 1, the UAE is second with 0.957983, and Georgia is third with 0.8782. Iran, with a TOPSIS score of 0.2815, is ranked fifteenth, showing an unfavorable situation in this component.

Business Complexity Component: The UAE leads this component with a TOPSIS score of 1, Saudi Arabia ranks second with 0.5373, and Lebanon third with 0.4348. Iran is ranked fourteenth with a TOPSIS score of 0.1926.

Global Innovation Output Components

Knowledge and Technology Outputs Component: Iran ranks first with a TOPSIS score of 1. The UAE and Turkey share the second place with a TOPSIS score of 0.7976. Yemen ranks last with a score of 0.

Creative Outputs Component: Turkey ranks first with a TOPSIS score of 1.000, Armenia second with 0.870, and the UAE third with 0.733. Iran ranks fifth with a TOPSIS score of 0.677, indicating a favorable position compared to the seven global innovation components.

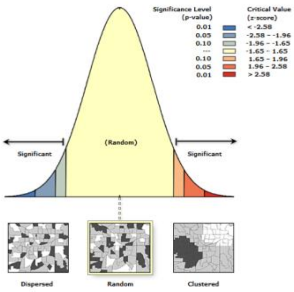
Overall, summarizing the rankings

The United Arab Emirates, Saudi Arabia, and Turkey have the highest TOPSIS scores at 0.861, 0.695, and 0.690, respectively, placing them in the first to third ranks. Iran, with a TOPSIS score of 0.630, ranks fifth, while Yemen, with the lowest score of 0.028, ranks last. According to the ranking, the sparsely populated Arab countries in the Persian Gulf region (UAE, Saudi Arabia, and Qatar) are in a favorable position regarding the studied innovation indicators.

Using the coefficient of variation (c.v) model shows that among the seven innovation components, the greatest inequality exists in the Business Complexity component (0.6652), while the least inequality is found in the Institutions and Higher Education & Human Capital components (0.488). Overall, the coefficient of variation (c.v) is 0.388, indicating a relatively deep gap among the selected countries and inequality in the development of innovation indicators.

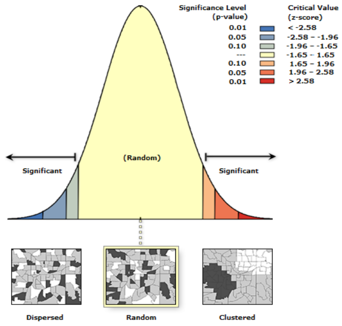
Analysis of the Spatial Distribution Pattern of Global Innovation Indicators in Selected Countries

As mentioned above, to identify the spatial distribution patterns of global innovation indicators in the studied countries, the global Moran's spatial autocorrelation method was used in the ARC GIS software environment. The Moran's index is one of the best indicators for detecting clustering (Mohammadi and Firoozi Majandeh, 2016). It determines whether neighboring areas generally have similar or dissimilar values. The Moran's value ranges between -1 and 1. A value close to 1 indicates clustered distribution, while a value close to -1 indicates a random distribution of elements. The model can be run based on different fields (population, gender, etc.), and the result is displayed as clustered, random, or dispersed on the model output map. Each of these patterns is described below.



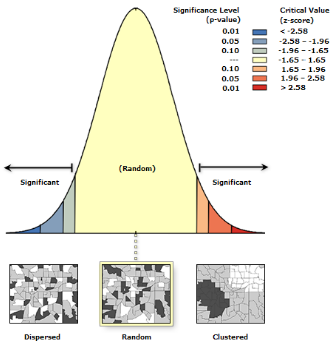
Moran's Index:	0.052541
Variance:	0.057782
z-score:	0.547658
p-value:	0.587661

Figure 1. Human Capital and Research



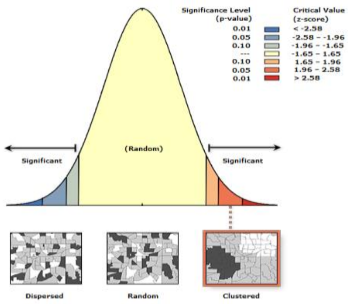
Moran's Index:	0.072447
Variance:	0.046324
z-score:	0.778865
p-value:	0.431359

Figure 2. Institutions Component



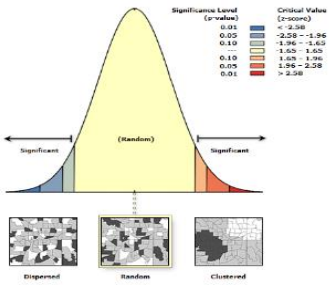
Moran's Index:	0.082119
Variance:	0.044987
z-score:	0.676512
p-value:	0.384753

Figure 3. Market Sophistication



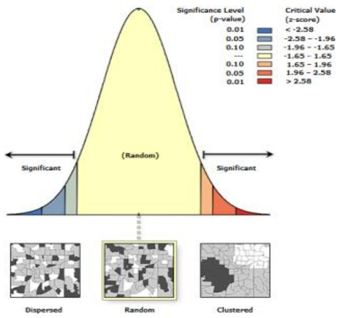
Moran's Index:	0.114857
Variance:	0.004339
z-score:	2.249735
p-value:	0.131166

Figure 4. Infrastructure



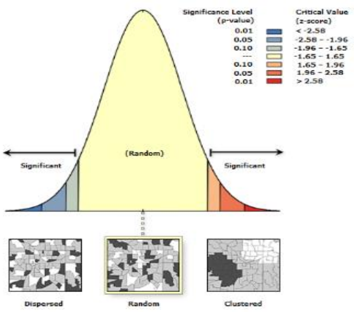
Moran's Index:	0.206802
Variance:	0.053654
z-score:	1.286052
p-value:	0.212472

Figure 5. Knowledge and Technology Outputs



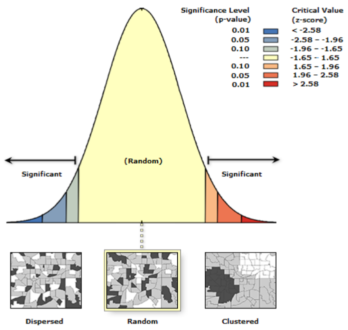
Moran's Index:	0.053147
Variance:	0.056313
z-score:	0.632145
p-value:	0.541681

Figure 6. Business Sophistication



Moran's Index:	0.064536
Variance:	0.041785
z-score:	0.754851
p-value:	0.455562

Figure 7. Overall Distribution of Innovation Index in the Region



Moran's Index:	0.012163
Variance:	0.042559
z-score:	0.984367
p-value:	0.324935

Figure 8. Creative Outputs

According to the results obtained above, the Moran's Index (Moran's I) in most of the seven innovation components, except for the infrastructure component (which shows a clustered pattern), is less than one. Therefore, we conclude that the spatial distribution pattern of the components among the countries in the West Asia region is random and unplanned. Overall, the dispersion pattern of the overall innovation indices in the studied region is random, with a Moran's Index value of 0.084536, which tends toward 1, indicating a movement toward clustering among countries. The expected mean distance is -0.0909, the nearest neighbor ratio is 1.277, and the calculated standard score is 0.456. Considering the p-value, we conclude that this randomness is statistically significant.

Conclusion

The innovation index recognizes the role of innovation as a key and important driver of economic growth and welfare of countries, ranking countries based on various aspects such as education, accessibility, talent motivation, and transfer of workforce across borders and cities. The Global Innovation Index (GII) is an important reference in innovation, used by policymakers as a tool to develop countries' innovation performance. Based on the objective and results of the analysis conducted in this study regarding global innovation indices among selected countries, the United Arab Emirates, Saudi Arabia, and Turkey ranked first to third respectively with the highest TOPSIS scores of 0.861, 0.695, and 0.690. Among them, Iran ranked fifth with a score of 0.630, while Yemen ranked last with the lowest score of 0.028. Other findings of the study showed that the greatest inequality is found in the business sophistication component (0.6652), and the least inequality in the institutions and higher education & human capital components (0.488). Considering these results and a glance at Iran's position in the 2018 Global Innovation Index annual report, it can be said that Iran's status in output indicators is suitable and above the average of high-income countries globally and regionally, while it is unfavorable in input indicators. Also, among the selected countries, the spatial distribution pattern of all innovation components except for infrastructure (which shows clustering) is random and unplanned. Additionally, examining Iran's position over the past 8 years shows that the country's innovation trend has faced many ups and downs.

By reviewing the Global Innovation Index report, it can be said that a comprehensive and balanced perspective on all factors influencing innovation is essential. A review of the latest country ranking data from the World Intellectual Property Organization indicates that the growth of countries' innovation indices—both over four-year periods (from 2015 to 2018) and in comparison with the previous year—has shown improvement in the vast majority of dimensions. However, it is noteworthy that despite the overall rise in the country's ranking in recent years, some dimensions related to innovation inputs do not have favorable rankings. This weakness and imbalance in the ranking of certain dimensions should not be overlooked despite significant growth and very good rankings in other dimensions, which have led to an improvement in the overall rank.

This significant growth of our country owes much to the improvement in dimensions such as knowledge and technology outputs (moving from rank 90 in 2015 to rank 41 in 2018) and creative outputs (from rank 116 in 2015 to rank 59 in 2018). Undoubtedly, the development of the innovation and entrepreneurship ecosystem, as well as the expansion of active startups in various economic sectors, has played a crucial role in achieving these positions.

Moreover, the findings of the 2018 report align with the results of this study, showing a favorable situation in innovation outputs (rank 1 in knowledge and technology outputs and rank 5 in creative outputs) while the status of innovation inputs, especially in the institutions pillar, remains unsatisfactory. Therefore, to improve the country's position in this ranking, coordinated actions and cooperation between policy-making institutions and organizations involved in the innovation ecosystem are required. These actions should focus on improving regulatory quality; transparency and governance of laws; enhancing the business environment (facilitating business startup and management); improving foreign investment laws; facilitating and encouraging foreign direct investment, joint ventures, government online services, electronic participation, strategic partnerships; and easing the import of advanced technologies.

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