RESEARCH ARTICLE

A New Index Proposal For Sustainable Cities

Turan Paksoy[1] , Mustafa Atilla Arıcıoğlu[2] , Büşra Yiğitol[3] , Aylin Yılmaz Gezgin[4]

[1](Prof. Dr.), Necmettin Erbakan University, Faculty of Engineering, Konya, Turkiye
[2](Prof. Dr.), Necmettin Erbakan University, Faculty of Political Sciences, Konya, Turkiye
[3](Asst. Prof.), Necmettin Erbakan University, Faculty of Aviation and Space Sciences, Konya, Turkiye
[4](Dr.), Karamanoğlu Mehmetbey University, Vocational School of Social Sciences, Karaman, Türkiye

ABSTRACT

Sustainability can be defined as meeting today's economic and social needs in such a way as to leave a livable environment for future generations without negatively impacting the ecosystem. Thus, one of the priorities today is to build cities and communities with sustainable living spaces. Such cities and communities are living spaces that meet the needs both of today and tomorrow in the most comprehensive and effective way. In this article, an index system is proposed to measure the sustainability of cities. The proposed sustainable city index was applied to Konya in Türkiye. The city was evaluated over three main dimensions and nine sub-dimensions. The annual increase and decrease of the index scores showed parallelism with the effects of the economic, technological, social and ecological events experienced in the last four years. The result of this study is of great importance as it shows the measurement reliability of the index. The sustainable city index can support recommendations that form the basis of policies and offer city-based performance scorecards for municipalities. It is recommended that city-based comparisons are made not only among cities in Türkiye but also worldwide in order to reach a better comparison.

Keywords: Competitiveness, Innovation, Liveability, Sustainability, City Index, Türkiye

1. Introduction

One of the most attractive aspects of the concept of competition is that it opens the door wide to greater possibilities of comparison (Porter, 2000; Giffinger et al., 2010). It allows for the comparison of many elements from products to companies, from individuals to national economies, from football teams to the talents of cities. However, what is essential in this comparison is the correct determination of the criteria, the correct selection of the comparison method, and the meaningfulness of the results obtained. This allows for new comparisons when integrated with correct feedback (Albella et al., 2017; Alaverdyan et al., 2017). Competition plays a role in understanding social development and economic differences, developing strategies, and regulating operational activities (Rainess, 2000). Current situation comparisons or competitive measurements for the development of countries and the future of companies offer the opportunity to test future targets (Porter, 1990; Olson et al., 1998; Ehmke, 2008; Porter, 2003). In the historical process, these comparisons have been used to understand sustainable life and success. This situation has naturally brought with it some discussions. At the beginning of these debates is the question of which factors in terms of welfare and development are the best guides for the inclusivity of competition (Erhard, 1958; Porter, 2001). This debate has flared up again with globalization after 1989. Competitive measures used for countries and companies have begun to be developed and used for cities as well. In fact, the decisiveness and importance of cities is not a new concept. In other words, the strategic importance of cities in establishing civilizations, comparing economic growth, and understanding international connections is a valuable proposition (Begg, 1999; Moulaert, 2000; Shen, 2004; Bruneckiene et al., 2012). The thesis that cities have an impact on the population distribution and demographic structuring of the world's geography, that economic developments have risen from cities in the historical process, and that cities actually shape the world has been strongly defended (Parkinson et al., 2003; Pirenne, 2016). Developments in the economy with globalization keep this thesis alive (Huavari et al., 2001; Kitson et al., 2004). New production, market and logistics maps emerging with strong networks (Rondinelli et al., 1998), the future of innovation and R&D, extraordinary periods such as pandemics (Iammarino et al., 2018), and endless wars reveal the strategic importance of cities. In addition, the geographical location of cities is of great importance since they are a connection point in international competition (Gordon, 2002; Huggins, 2003; Castless, 1998). In addition to providing efficiency in productivity and competition, cities have

risen to the status of specialization centers in knowledge, innovation, production and services (Paskaleva, 2009). In particular, the high density of people indicates an increase in social capital and the existence of more and more opportunities for interaction and communication.

This situation encourages creative thinking and paves the way for the emergence of new ideas and technologies (De Souza Briggs, 1997; DeFillipis, 2001). A report published by the European Union states that cities constitute 80% of all economic growth (EU, 2006). This result also reveals that cities have an important economic value. Therefore, cities are the mediators of social, cultural, economic, technological and political changes and progress. In this context, the ability of cities to be competitive has been discussed over different forms and evaluations. Indeed, there are a variety of features which make cities competitive (Westwood and Nathan 2002). The manner in which production, tourism, and trade are increased through incentives for physical structuring, which are frequently used to increase direct investment, taxation advantages, incentive payments and infrastructure support (Lever and Turok, 1999; Doğan and Minister, 2020) should be measured and evaluated. Similarly, the criteria that will determine whether a city is livable beyond investment and physical support should also be determined. These criteria are elements that define and facilitate human life such as social capital, education and health. Another main factor that supports and complements these two factors (competitiveness and liveability) is innovation. R&D and technology, which increase intellectual accumulation, determine the existence and level of innovation. They also make life easier and improve/transform production, giving meaning to the liveability of the city (Bruneckiene et al., 2012; Republic of Turkey Ministry of Development, 2014; Pinochet et al., 2019). These three main criteria seek to determine the nature of a city, not only for those living there, but also for those who want to live, invest and express themselves in that place (Amin and Thrift, 2002; Akman and Arıcıoğlu, 2019). This also teaches us that it is necessary to know the environmental factors that cause the rapid increase in a city's population, the deterioration of the ecological balance, the increase of environmental pollution and the inefficient use of natural resources (Kamal-Chaoui and Robert, 2009). In particular, the sustainability of cities is negatively affected as a result of ineffective and inefficient use of resources. As a result, the balance of production and consumption deteriorates, and a challenging period for cities begins. In the light of this deterioration, , many studies have been carried out and ways such as efficient use of resources, widespread use of smart city applications and taking measures on a global/local scale have been investigated. Initiatives such as "Green Cities", "Ecological Cities" and "Techno Cities" are being implemented for a fairer and more efficient use of city resources. Thanks to these breakthroughs, the sustainability of cities and the effective use of resources are ensured (Anthopoulos and Fitsilis, 2014; Roy, 2016). While all these ensure that the scale, geopolitical position and strategic nature of a city are taken into account, they also form the basis for understanding its liveability and sustainability within a competitive approach (Harrison & Donnelly, 2011; Sofronijević et al., 2014).

In first section of this study the place of the theory of a sustainable city index study is discussed. Then, the characteristics of city index studies in the literature are mentioned. In the last section, we report on the sustainable city position of Konya in Türkiye which was tested with the developed calculation method.

2. Scales and Comparisons for Cities

The economic, demographic, cultural and spatial characteristics of cities differ from each other (Brenner, 1998). For this reason, the competitiveness of cities is discussed with different index studies (TUİK, 2016; EDAM, 2016; URAK, 2018; EPI, 2022; SEGE, 2022; WEF, 2023; Aihemaiti, 2018; Akdamar, 2018; Berger, 2019; Çoruh, 2021; Vodafone, 2016).

2.1. The importance of Global and National Scales in Comparing Cities

Indexes, which are used in many fields of social and human sciences, are frequently used for different concept sets as well as for learning many values of daily life as a unified measurement model/type. In its most basic form, an index is a numerical measure that summarizes the differences in the values of a particular statistical event over time or place. An index is an indicator or measure of something (Liv d., 2014). Many index studies such as the CPI, Political Activity Index, Innovation Index, and Livable Countries Index provide information to everyone, from individuals to institutions, from companies to governments, and guide the transaction processes. With their contribution to qualification and evaluation, indexes have attracted attention over the last 60 years particularly as measurement forms not only used but also produced by institutions (Martens et al., 2014). In addition to global structures such as the United Nations, the World Bank, and the ILO, national or local institutions for Türkiye such as the Turkish Statistical Institute (TURKSTAT), the Council of Higher Education (CoHE), the Turkish Academy of Sciences (TÜBA), the Turkish Foundry Association (TUDOKSAN), and the ISO try to provide a useful perspective with the indexes they produce. They also try to integrate with the global world by means of these index studies. Included in the latter are city index studies, which reveal the differences of values related to cities according to time, and which, most importantly, allow cities to be compared with each other. In particular, city indexes become a reference point in order to predict the future development levels of cities, evaluate their strengths and weaknesses, and decide whether they are an attraction point for investment and tourism (Blancas et al., 2011;

Baidal et al., 2019). Currently, many index studies used for this purpose can be found in the literature. The following indices can be shown as examples.

In Table 1, examples of city index studies in the world are given. The dimensions, criteria and purpose of these indexes are presented:

Table 1. Examples of city index studies in the world

Index	Core Dimensions/Sub-Dimensions	Criteria	The purpose of Index
Global Innovation Index (Dutta et al., 2021)	This index measures 7 main functions. Institutions, Human capital and research, Infrastructure, Markets, Businesses, Information and Technological infrastructure, Creative outputs	Evaluations were made on 18 sub-criteria.	This study was carried out in order to reveal innovative countries.
Environmental Performance Index (EPI, 2022)	Environmental health was evaluated under two main headings: climate change and ecosystem vitality. Sub-dimensions: Climate change, Air pollution, Hygiene and drinking water, Waste management, Fishery, Agriculture, Water resources, Ecosystem services, Acid rain, Biodiversity, Heavy metal	It was an index that summarized the criteria related to sustainability.	It evaluated 180 countries in terms of climate change performance, environmental health and ecosystem vitality.
World Economic Forum Global Competitiveness Index (Schwab and Zahidi, 2020)	The study was carried out on 5 main dimensions. Government, Resource efficiency, Intellectual capital, Social capital, Nature capital	The study was carried out on 120 quantitative indicators.	An index study was used to measure the real competitiveness of countries.
World Economic Forum Energy Transition Index (WEF, 2023)	The Energy Transition Index study consists of two basic dimensions: System performance and Transition Readiness. These dimensions are evaluated over five sub-dimensions. Equity, safety, sustainability are factors that interact with investment and building regulators.	The study was carried out on 40 variables.	It evaluated the transition of 115 countries to energy systems. It was carried out in order to evaluate the sustainability of using clean energy sources...
Solability Social Capital Index (Solability, 2022a)	Social capital index was evaluated under 5 basic parameters. It was driven by health, equality, crime, freedom and satisfaction.	Evaluations were made on 15 sub-variables.	Social capital provides a stable environment for the economy. For this reason, the welfare of countries was evaluated through social capital arguments.
Solability Governance Index (Solability, 2022b)	It was evaluated over 5 main dimensions. Corruption, Financial Stability, Business Environment, Government Consistency, Infrastructure	Evaluations were made on 15 sub-variables.	Government systems were evaluated on quantitative data.
City Protocol (CPA-I, 2015)	It was evaluated on three main dimensions: structure, interactions and society. Building dimension; environment, infrastructure and multiple domains, Interactions dimension: functions, economy, knowledge and culture.	It was evaluated over 198 criteria.	The criteria were evaluated according to the City Protocol ISO 37120 standard.
Ericsson City Index (Ericsson, 2016)	Community dimension: civil society and government, Ericsson's digital society index was evaluated under 6 main headings. Social, Economic, Environment Infrastructure, Affordability, Environmental use	It was evaluated over 42 indicators.	Smart city solutions were researched for 40 cities in the world.
Siemens Green City Index (SIEMENS, 2012)	It consists of air quality, water, carbon dioxide absorption, waste and land use, transportation, buildings, energy and environmental management dimensions.	The study was carried out on 32 indicators.	It focuses on the environmental factor while making smart propositions.
Global Innovation Index (Dutta et al, 2021)	It was measured over 7 basic main functions. Institutions, human capital and research, infrastructure, markets, businesses, information and technological infrastructure and creative outputs	Evaluations were made on 18 sub-criteria.	This study was carried out to reveal the innovativeness of the countries.

Table 2 presents examples of city index studies in Türkiye. The dimensions, criteria and purpose of these indexes are presented:

Table 2. Examples of city index studies in Türkiye

Index	Core Dimensions/Sub-Dimensions	Criteria	The purpose of Index
TURKSTAT Life Index (TÜİK, 2016)	The index has 11 dimensions. Housing, Work life, Income and wealth, Health, Education, Environment, Security, Civic participation, Access to infrastructure services, Social life, Life satisfaction	It was carried out on 11 basic dimensions and 41 subvariables.	It evaluates the liveability of cities through social, economic and life satisfaction.
Socio-Economic Development Index (SEGE, 2022)	It consists of demographics, employment and social security, education, health, finance, competitiveness, innovation and quality of life.	Socio-economic development was measured using 56 variables.	The Socio-Economic Development Index (SEGE) is an analysis study that objectively measures and compares the socio-economic development of NUTS-2 regions, provinces and districts in Türkiye in order to provide input to policy, strategy and public practices.
Inter-Provincial Competitiveness Index (URAK, 2018)	It consists of 4 dimensions: Human Sub-Capital Index, Innovation Sub-Index, Production and Trade Sub-Index, and Liveability Sub-Index.	It is carried out over 85 subvariables.	This index study is carried out in order to carry the economic power of the cities further.
City Mobile Index (Deloitte, 2018)	It consists of resilience and performance, leadership and vision, and service and engagement.	Evaluations are made on 15 subvariables.	It assesses city mobility.
A Competitiveness Index for Turkish Regions (EDAM, 2016)	It is calculated with 8 sub-indexes. Labor market index, human capital index, creative capital index, social capital index, macroeconomic stability index, market size index and financial depth index	The competition index of cities is evaluated over 65 criteria over 8 main dimensions.	In order to understand how much the competitiveness index reflects the productivity level on a city basis, the growth indicators of the index are examined.
Digitalization Indexes (Çoruh, 2021)	It consists of Smart Technology, Technology Infrastructure, Technology Adoption, Smart Human, Human Capital, Meeting Human Needs, Smart Governance, Municipal Governance, Smart City Applications, Smart Economy Ease of Doing Business, Environment of Innovation, Digital Market.	88 indicator, 9 CBF, 4 dimensions.	The aim of this study was to calculate the weighted and unweighted urban digitalization indexes (UDI) values and to rank the cities based on these values.
Smart Cities (Aihemaiti, 2018)	It consists of Smart People, Smart Living, Smart Governance, Smart Mobility, Smart Environment, Smart Economy, General Performance.	66 indicators	This paper aims to demonstrate a ranking model to evaluate smart cities
Smart City Road Map (Vodafone- Deloitte, 2016)	It consists of smart people, smart life, smart environment, smart transportation, smart economy, smart governance.	6 indicators	It aims to measure and evaluate how smart cities are.

City index studies are carried out to reveal the attractiveness of a city through variables and dimensions that are specific for

some cities (Choon et al., 2011; Giap et al., 2014; Lee et al., 2015). These studies develop indexes to evaluate the competitiveness of cities in industry, tourism and trade and to reveal their development in education, health and transportation. The indexes also aim to reveal the advantages of cities using technology and R&D studies. The reason for developing city indexes is that, while evaluating the benefits and shortcomings of urbanization, they determine the coexistence of different groups of people (Alderete, 2019; Lai and Cole, 2023).

An examination of previous studies in the literature reveal that the dimensions of competitiveness (SEGE, 2022), liveability (URAK, 2018) and innovation (Dutta et al., 2021) are evaluated separately. In this study, three separate issues were combined into a single scale in the city competitiveness index. In this respect, the study is important in revealing the sustainability of cities through the dimensions of competitiveness, liveability and innovation. Indeed, the results of the study make it easier for citizens living in the city and for investors to evaluate the competitiveness of that city. It is also thought that the study will shed light on urban planning because it presents the index result both on a departmental basis and as a total and gives local municipalities the opportunity to perform a SWOT analysis. In addition, index studies on smart cities, techno cities and green cities have been carried out in the literature. These studies provide evaluations on ensuring the sustainability of cities. The sustainable city index study contributes to sustainability issues through the effective and efficient use of resources.

The sustainable city index study consists of three basic dimensions (competitiveness, liveability and innovation), nine sub-dimensions and eighty-seven variables.

In this study, the competitiveness dimension is used first. The competitiveness dimension uses variables that express the economic development of cities. It is preferred in order to position the city in tourism, industry and trade and to show its differences from other cities with its features (Dutt et al., 2021; SEGE, 2022; EDAM, 2016). The competitiveness dimension consists of three sub-dimensions, namely industrial development, tourism and trade, and twenty-five variables related to these dimensions.

The city's achievements in the field of education, the wideness of its transportation network, its strength in the field of health and its success in the field of social capital allow all kinds of people to live in that city. In this case, it contributes to the increase in the population of the cities and their competitiveness. The sum of these values indicates liveability (URAK, 2018; Solability, 2022a; Schwab and Zahidi, 2020). The second dimension of the sustainable city index study is liveability. The liveability dimension consists of four sub-dimensions, namely health, transportation, education and social capital, and fifty-two variables related to them.

The reason why the innovation dimension is preferred is that the information and technological developments of the cities increase the living welfare of the people. It also helps cities to compete. The fact that a city has a good economic, social, political and historical level causes it to become a center of attraction (CPA-I, 2015; SEGE, 2022). Innovation was chosen as the third dimension of the sustainable city index study. The innovation dimension consists of technology and R&D sub-dimensions and evaluates over six variables.

This index can be used for 81 provinces in Turkey. The data used in this study were collected on the basis of thousandths for algorithmic fit. Evaluation of the criteria was made on the basis of economic, social and technological factors. The index results of each city were obtained over the scores obtained.

3. Research framework

In this section, information about the sustainable city index is given, and the methodology of the research and the sample application are mentioned.

3.1. Sustainable city index: proposed method and case study

In this article, a model is proposed that allows all cities to be evaluated through a common language in order to reveal the performance of sustainable cities. This model not only allows the performance of cities to be obtained, but also provides the opportunity to compare between cities. The sustainable city index consists of three main dimensions and sub-dimensions of each main dimension. In determining the dimensions, major indexes in the literature such as Global Innovation Index, World Economic Forum Global Competitiveness Index, Solability Social Capital Index, URAK Inter-Provincial Competitiveness Index, EDAM Türkiye Competitiveness Index and ISO Sustainable cities and communities index were used.

In this context, the sustainable city index consists of competitiveness, liveability and technology dimensions interpreted through economic, social and technological values. In the sub-dimensions, the competitiveness indicators include the dimensions of industrial development, trade and tourism. Liveability indicators include the dimensions of health, transportation, education and social capital. Innovation indicators include technological developments and R&D dimensions (Fig. 1)
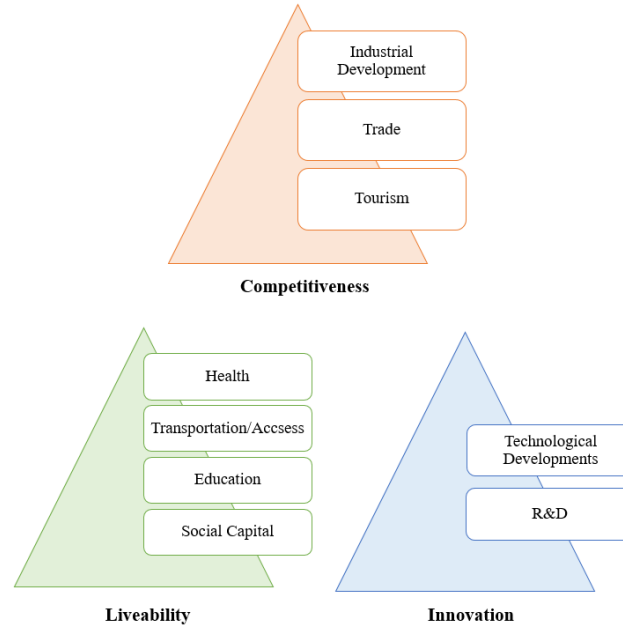
Figure 1. Sustainable city index model

The index study was carried out on Konya, a city in Türkiye, for pilot implementation. Konya is the largest city in Türkiye in terms of surface area and has 31 districts (Fig. 2). The population of 2022 was 2,296,347. Municipal services have been carried out in the city according to its "metropolitan" status since 1989. It houses 2.37% of the population of Türkiye and ranks 6th among the most populous cities of the country.
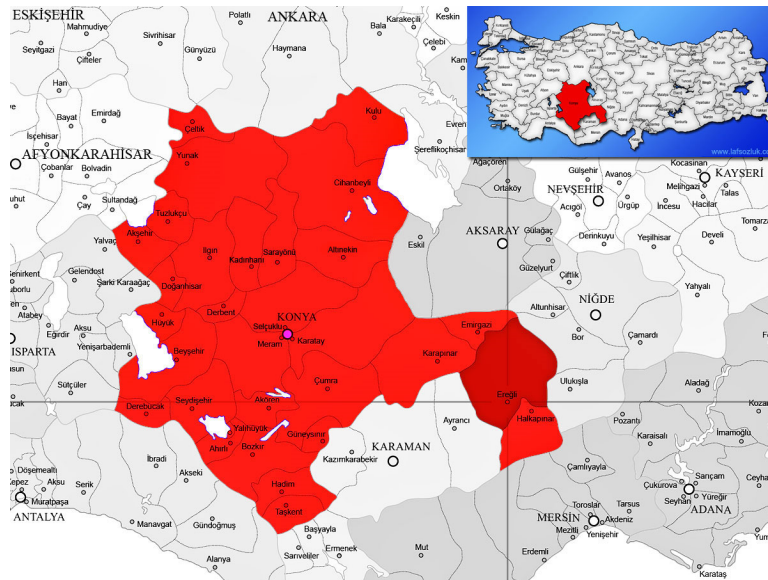
Figure 2. Sample city

Konya is one of the most economically developed cities of Türkiye. Industry in Konya includes many sectors today. As it has many sectors, it has also added the identity of an industrial city to its historical identity as a granary. Another feature of Konya is that its industry is not based on certain types of products. Production is carried out in a very wide sectoral area in Konya. In other words, it operates in quite different production areas from machinery industry to chemistry, from textiles to automotive spare parts, from electrical electronics to food, from packaging to paper industry. Konya's industry share in the GDP is 30.7% and it ranks 5th

in the number of industrial enterprises in Türkiye. It has the 6th highest number of organized industrial zones. Regionally, it can be defined as the third region with the lowest unemployment rate (Mevlana Kalkınma Ajansı, 2023).

3.2. Methodology of the proposed method

A special calculation method was used for the sustainable city index model. Data were obtained from the Turkish Statistical Institute (TURKSTAT), municipality statistics, ministries of the Republic of Türkiye and organizations which have operated in economic and social fields for a long time and at the same time which are internationally accepted. Index indicators exhibit a heterogeneous structure (Appendix A). In other words, the index consists of items with different measurement values. These different types of data need to be expressed on a common parity. Therefore, these indicators, which are expressed over different unit values, have been transformed into a common expression form. In other words, the normalization process was applied. For this purpose, all items in the study were re-evaluated on a 10-point Likert scale, and all data were assigned exact values from 1 to 10. A methodology based on the research framework was adopted in the creation of the Likert scale for each index item. The normalization process and the methodology of the research were followed in the steps indicated in Figure 3.
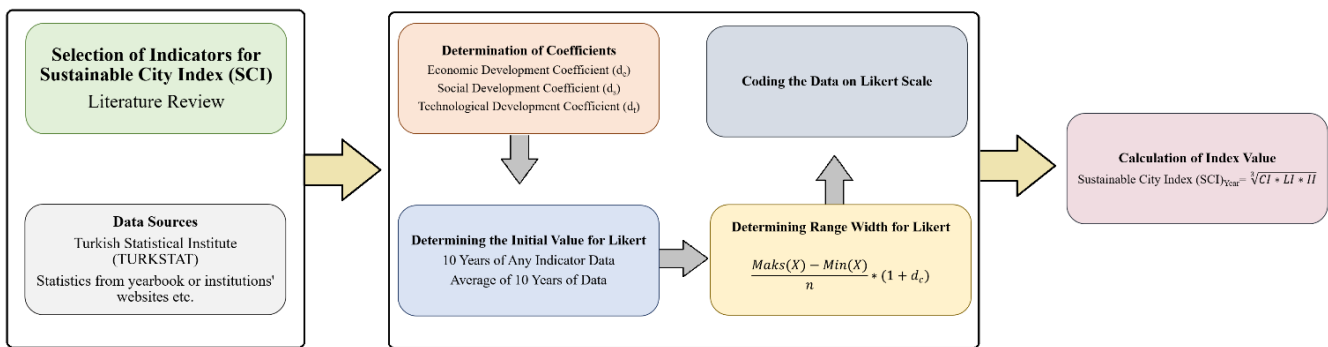
Figure 3. Methodology and flowchart of the research

As stated in the flowchart, normalization was made after determining the indicator items for the index and extracting the data from various sources. For normalization, coefficient calculations were made first. After the coefficient calculations, the average value of the 10-year data of each index indicator was calculated to determine the initial value of the Likert scale. In the third stage, the range width for each index item was calculated with the help of the formula given in Figure 3. Then, the index indicator was coded on a scale of 1-10 and the sustainable city index score was calculated with the help of the formula given in Figure 3.

3.3. Calculation of coefficients

In the research, three different coefficients were calculated, namely economic, social and technological development. GDP, which is one of the best indicators for economic development, population for social development and patent application number for technological development were used.

a) Economic Development Coefficient (d_e)

For the economic development coefficient, the annual growth of the last 20 years of GDP (in millions of dollars) was calculated. The economic development coefficient (de) was calculated over the average 20-year growth rate (Figure 4).

Figure 4. Flowchart of Economic Development Coefficient (d_e)

Annual GDP Value growth rate[1] ;

$$\frac{X_n - X_{n-1}}{X_{n-1}}$$

Table 3. Country GDP for the last 20 years (Million Dollars)

Year	Total GDP (Million Dollars)	Annual GDP Value growth rate
2002	230494	-
2003	304901	0.32
2004	390387	0.28
2005	481497	0.23
2006	526429	0.09
2007	648754	0.23
2008	742094	0.14
2009	616703	-0.17
2010	731608	0.19
2011	773980	0.06
2012	786293	0.02
2013	823044	0.05
2014	799370	-0.03
2015	719967	-0.10
2016	862744	0.20
2017	851490	-0.01
2018	784087	-0.08
2019	760778	-0.03
2020	716902	-0.06
2021	807106	0.13
2022	905501	0.12
Average of annual GDP Value ($) growth rate		**0.079**
d_e		

Resource: Turkish Statistical Institute (TURKSTAT)

b) Social Development Coefficient (d_s)

The social development coefficient was calculated for the liveability indicators included in the index. For the social development coefficient. annual comparisons were made over the population of the last 20 years and the growth was calculated. The social development coefficient (ds) was calculated over the average 20-year growth rate (Figure 5).

Figure 5. Flowchart of Social Development Coefficient (d_s)

---

[1] https://www.mahfiegilmez.com/2013/09/gsyh-ve-buyume-hesaplamalar-turkiye.html

Annual Population Growth Rate;

$$\frac{X_n - X_{n-1}}{X_{n-1}}$$

Table 4. Country population for the last 20 years

Year	Türkiye Population	Annual growth rate
2002	66401851	-
2003	67187251	0.012
2004	68010215	0.012
2005	68860539	0.013
2006	69729967	0.013
2007	70586256	0.012
2008	71517100	0.013
2009	72561312	0.015
2010	73722988	0.016
2011	74724269	0.014
2012	75627384	0.012
2013	76667864	0.014
2014	77695904	0.013
2015	78741053	0.013
2016	79814871	0.014
2017	80810525	0.012
2018	82003882	0.015
2019	83154997	0.014
2020	83614362	0.006
2021	84680273	0.013
2022	85279553	0.007
Average of Annual Population Growth Rate d_s		**0.013**

Resource: Turkish Statistical Institute (TURKSTAT)

c) Technological Development Coefficient (d_t)

The technological sophistication coefficient was calculated for the innovation indicators. For the technological development coefficient, annual comparisons were made over the number of patent applications for the last 20 years and the growth was calculated. The technological development coefficient (dt) was calculated over the average 20-year growth rate (Figure 6).

Figure 6. Flowchart of Technological Development Coefficient (d_t)

Annual Patent Application Increase Rate;

$$\frac{X_n - X_{n-1}}{X_{n-1}}$$

Table 5. Distribution of Patent Applications by Years

Year	Number of Patent Applications	Annual Patent Application Increase Rate
2002	1874	
2003	1152	-0.385
2004	2262	0.964
2005	3461	0.530
2006	5165	0.492
2007	6189	0.198
2008	7137	0.153
2009	7241	0.015
2010	8343	0.152
2011	10241	0.227
2012	11599	0.133
2013	12055	0.039
2014	12375	0.027
2015	13958	0.128
2016	16778	0.202
2017	19283	0.149
2018	18504	-0.040
2019	19916	0.076
2020	18705	-0.061
2021	17566	-0.061
2022	15856	-0.097
Average of Annual Application Increase Rate d_t		**0.142**

Resource: TÜRKPATENT

The economic, social and technological coefficients were calculated as above and summarized in Figure 7.

d_e	d_s	d_t
• 0.079	• 0.013	• 0.142
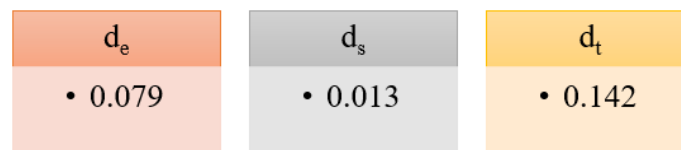
Figure 7. Coefficients Summary

3.4. Determination of range width

1. Determining the range width with the economic coefficient

A Likert scale was created using the economic development coefficient for any item in the competitiveness dimension of the index. By way of example, the number of ATMs per thousand people specified in Appendix B was calculated. The initial value of the scale was determined based on the number of ATMs per thousand people of all cities for the last decade. For this, the average value was calculated. Accordingly, the average number of ATMs per thousand people in all cities (Average Value) is 0.445.

After determining the initial value of the scale, the range width was calculated. For the range width, the maximum and minimum values of the ATM number data in Appendix B and the economic development coefficient were calculated with the help of the following formula.

Range Width: $((Maks.- Min)/n)*(1+d_e) = ((1.207-0.105)/10)*(1+0.079)=0.119$

After range width calculation, a 10-point Likert scale was created for the index item "Number of ATMs per thousand people" as in Figure 8.

1	2	3	4	5	6	7	8	9	10
+0.119	+0.119	+0.119	+0.119	+0.119	+0.119	+0.119	+0.119	+0.119	+0.119

0.445   0.564   0.683   0.802   0.92   1.039   1.158   1.277   1.396   1.515   1.634

Figure 8. Likert scale for number of ATMs per thousand people

After the Likert Scale was created, the value of the sampled city data was assigned on the scale. The value assignment of the city data is given in Table 6.

Table 6. Number of ATMs per thousand people in Konya (Code: CTR11)

	Data before normalization	**Data after normalization**
2012	0.283	0
2013	0.322	0
2014	0.362	0
2015	0.375	0
2016	0.373	0
2017	0.371	0
2018	0.365	0
2019	0.366	0
2020	0.362	0
2021	0.357	0

2. Determining the range width with the social coefficient

A Likert scale was created using the social development coefficient for any item in the liveability dimension of the index. As an example, "the number of doctors per thousand people" specified in Appendix C was taken. The initial value of the scale (average value) was determined based on the number of doctors per thousand people of all cities for the last decade. Accordingly, the "average number of doctors per thousand people" in all cities was calculated as 1.559.

After determining the initial value of the scale, the range width was calculated. For the range width, the maximum and the minimum values of the number of doctors per thousand people in Appendix C and the social development coefficient were calculated with the help of the formula below.

Range Width: $((Maks.- Min)/n)*(1+d_s)= ((3.4-0.7)/10)*(1+0.013)=0.274$

After the range width calculation, a 10-point Likert scale was created as in Figure 9 for the index item "number of doctors per thousand people".

1	2	3	4	5	6	7	8	9	10
+0.274	+0.274	+0.274	+0.274	+0.274	+0.274	+0.274	+0.274	+0.274	+0.274

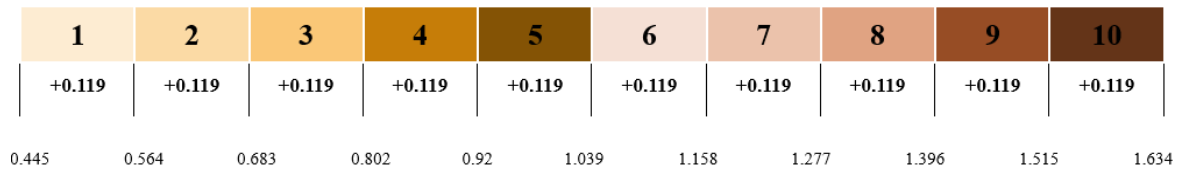1.559   1.833   2.106   2.380   2.653   2.927   3.200   3.474   3.747   4.021   4.294
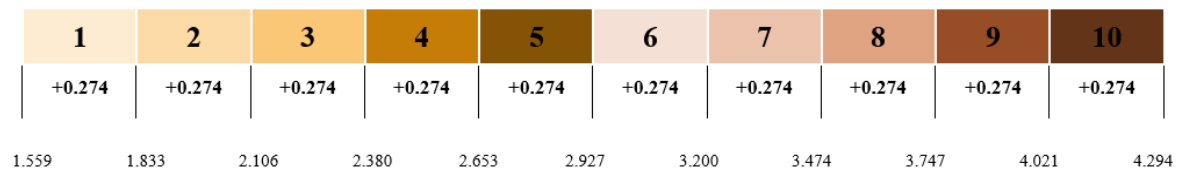
Figure 9. Likert scale for number of ATMs per thousand people

After the Likert Scale was created, the value of the sampled city data was assigned on the scale. The value assignment of the city data is given in Table 7.

Table 7. Number of doctors per thousand people in Konya (Code: LH3)

	Data before normalization	Data after normalization
2011	1.7	1
2012	1.8	1
2013	1.8	1
2014	1.8	1
2015	1.8	1
2016	1.8	1
2017	1.9	2
2018	1.9	2
2019	2	2
2020	2	2

3. Determining the range width with the technological coefficient

A Likert scale was created using the technological development coefficient for any item in the innovation dimension of the index. By way of example, "the number of trademark applications per thousand people", which is also stated in Appendix D, was taken. The initial value of the scale (average value) was calculated based on the number of trademark applications per thousand people of all cities for the last decade. Accordingly, the average number of trademark applications per thousand people in all cities was calculated as 0.681.

After determining the initial value of the scale, the range width was calculated. For the range width, the maximum and minimum values of the number of trademark applications per thousand people in Appendix D and the technological development coefficient were calculated with the help of the formula below.

Range Width: $((Maks.- Min)/n)*(1+d_t)= ((5.337-0.041)/10)*(1+0.142)=0.605$

After the range width calculation, a 10-point Likert scale was created as in Figure 10 for the index item "number of trademark applications per thousand people".

1	2	3	4	5	6	7	8	9	10
+0.605	+0.605	+0.605	+0.605	+0.605	+0.605	+0.605	+0.605	+0.605	+0.605

0.681 1.286 1.891 2.495 3.100 3.705 4.310 4.915 5.519 6.124 6.729
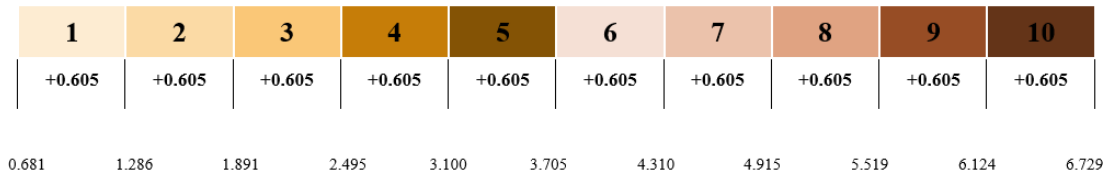
Figure 10. Likert scale for data on number of trademark applications per thousand people

After the Likert Scale was created, the value of the sampled city data was assigned on the scale. Value assignment of city data is given in Table 8.

Table 8. Number of trademark applications per thousand people in Konya (Code: IRD2)

	Data before normalization	Data after normalization
2013	1.321	2
2014	1.184	1
2015	1.15	1
2016	1.179	1
2017	1.308	1
2018	1.261	1
2019	1.369	2
2020	1.881	2
2021	2.293	3
2022	2.867	4

4. Results

For the sustainable city index study, assignments were made on a scale of 1-10. Data below the initial value of the scale and missing data were coded with "0". Table 9 shows the performance of each indicator for the city between the years 2019 and

2022. The table includes the 4-year change of each index indicator. The change of index indicators over the years reveals how great an improvement the city achieved over the determined values. Accordingly, the item "industry employment rate" in the industry development sub-dimension increased in 2020 compared to the previous year and maintained this level in other years. In the sub-dimension of tourism, no change was observed over the years. In the sub-dimension of trade, the item "the rate of import value per thousand people" increased compared to the previous two years. In the health dimension, which is one of the sub-dimensions of liveability, the item "number of nurses per thousand people" increased in 2020 compared to the previous year. In the transportation sub-dimension, "Number of cars per thousand people", "Number of pickup trucks per thousand people" and "Number of Fixed Broadband Subscriptions per thousand people" increased, while the item " Number of Fixed Telephone Access Lines per thousand people" tended to decrease over the years. In the education sub-dimension, the item "literacy rate" has a higher value than the other indicators, while "number of students per thousand people (postgraduate)", "number of females in university education per thousand people (postgraduate)" and "number of graduates per thousand people" items increased over the years. In the social capital sub-dimension, the item "divorce rate in one year" increased over the years. In the innovation dimension, the item "The number of trademark applications per thousand people" increased in the R&D sub-dimension.

Table 9. Coding of each indicator from the targeted value on Likert levels

Dimension	Sub-dimension	Indicator	2019	2020	2021	2022
COMPETITIVENESS (C)	Industry Development (I)	CI1	0	0	0	0
		CI2	1	1	1	0
		CI3	1	1	1	0
		CI4	0	1	1	0
		CI5	1	1	1	0
		CI6	1	1	1	0
		CI7	0	0	0	0
		CI8	1	1	1	0
	Tourism (T)	CT1	1	1	1	0
		CT2	0	0	0	0
		CT3	0	0	0	0
		CT4	0	0	0	0
		CT5	0	0	0	0
		CT6	0	0	0	0
	Trade (TR)	CTR1	0	0	0	0
		CTR2	0	0	0	0
		CTR3	1	1	1	0
		CTR4	1	1	1	0
		CTR5	0	1	1	0
		CTR6	1	1	1	0
		CTR7	0	0	0	0
		CTR8	1	1	1	0
		CTR9	1	1	1	0
		CTR10	2	2	2	0
		CTR11	0	0	0	0
		CTR12	1	1	3	0
		CTR13	1	1	1	0
		CTR14	1	1	1	0
INNOVATION (I)	R&D	IRD1	1	1	1	0
		IRD2	2	3	4	0
	Technology (T)	IT1	1	1	1	0
		IT2	1	1	1	0
		IT3	0	0	0	0
		IT4	1	1	1	0
		IT5	0	1	1	0
	Health (H)	LH1	0	0	0	0
		LH2	2	2	0	0
		LH3	2	2	0	0
		LH4	0	0	0	0
		LH5	0	0	0	0
		LH6	2	4	0	0
		LH7	0	0	0	0
		LH8	1	1	1	1
		LH9	0	0	0	0

Dimension	Sub-dimension	Indicator	2019	2020	2021	2022
LIVABILITY (L)	Transportation/access (T)	LT1	2	2	3	3
		LT2	1	1	1	1
		LT3	0	0	0	0
		LT4	3	0	1	0
		LT5	3	0	1	0
		LT6	2	2	2	3
		LT7	0	0	0	0
		LT8	2	2	2	3
		LT9	4	4	3	3
		LT10	0	0	0	0
	Education (E)	LE1	3	3	3	3
		LE2	1	1	0	0
		LE3	1	1	1	0
		LE4	0	0	2	0
		LE5	0	0	0	0
		LE6	0	0	0	0
		LE7	1	1	1	1
		LE8	0	0	0	0
		LE9	1	1	1	2
		LE10	0	0	1	1
		LE11	1	0	0	0
		LE12	1	1	1	0
		LE13	1	0	0	0
		LE14	1	0	0	0
		LE15	1	0	0	0
		LE16	1	1	1	0
		LE17	0	0	0	0
		LE18	1	0	0	0
		LE19	1	1	0	0
		LE20	0	0	0	0
		LE21	1	1	2	2
		LE22	3	0	0	0
		LE23	2	1	1	2
	Social capital (SC)	LSC1	1	1	0	0
		LSC2	0	0	1	1
		LSC3	0	0	0	0
		LSC4	1	1	1	0
		LSC5	2	2	0	0
		LSC6	0	0	0	0
		LSC7	0	0	0	0
		LSC8	1	1	3	3
		LSC9	0	0	0	0
		LSC10	1	0	1	1

Legend: 0-Low (red) … 10-High (dark green)

The arithmetic average was used to determine the values of the sub-dimensions of the three main dimensions of the sustainable city index. The arithmetic mean of the sub-indexes is summarized in Table 10.

Table 10. Arithmetic mean of sub-dimensions

		2019	(%)Change	2020	(%)Change	2021	(%)Change
Competitiveness (CI)	Industry Development	0.625	-	0.75	0.20	0..75	0..00
	Tourism	0.167	-	0.167	0.00	0.167	0.00
	Trade	0.714	-	0.786	0.10	0.929	0.18
Livability (LI)	Health	0.778	-	1	0.29	0.111	-0.89
	Transportation/access	1.7	-	1.1	-0.35	1.3	0.18
	Education	0.913	-	0.522	-0.43	0.609	0.17
	Social Capital	0.6	-	0.5	-0.17	0.6	0.20
Innovation (II)	R&D	1.5	-	2	0.33	2.5	0.25
	Technology	0.6	-	0.8	0.33	0.8	0.00

*As the data for 2022 had not been published yet, they were not included in the calculation in this article

An examination of the averages indicated in Table 10 shows that , while the industrial development index and tourism index, which are sub-dimensions of the competitiveness dimension, have achieved a stable level for the last two years, the trade sub-indexes have increased. An examination of the sub-indexes of the liveability index show that the indexes other than the health index increased compared to the previous year. When the sub-indexes of the innovation index are examined, the technology index progressed at the same level as the previous year, while the R&D index increased compared to the previous years.

Table 11. Arithmetic mean of sub-dimensions

	2019	(%)Change	2020	(%)Change	2021	(%)Change
Competitiveness (CI)	0.502	-	0.567	0.13	0.615	0.08
Liveability (LI)	0.998	-	0.78	-0.22	0.655	-0.16
Innovation (II)	1.05	-	1.4	0.33	1.65	0.18

Average values reveal a general value rather than considering each item separately. In addition, the average value both allows an understanding of the clear image of the city over the years and a comparison of other cities with each other in terms of sub-indexes. In this respect, when the average of the three main dimensions of the sustainable city index is considered, the competitiveness score increased by 8% in 2021 compared to the previous year and rose to 0.615 points (See Table 11). The liveability score depreciated by 16% compared to the previous year and regressed to 0.655 points. The innovation score increased by 18% compared to the previous year and reached 1.65 points.

The sustainable city index score was calculated using the averages of the main dimensions. The sustainable city index score was determined for each year using the formula below.

$$Sustainable\ City\ Index(SCI)_{Year} = \sqrt[3]{CI * LI * II}$$

Accordingly, the index score calculation for 2019:

$$SCI_{2019} = \sqrt[3]{0.502 * 0.998 * 1.05} = 0.807$$

The index score calculation for 2020:

$$SCI_{2020} = \sqrt[3]{0.567 * 0.78 * 1.4} = 0.853$$

The index score calculation for 2021:

$$SCI_{2021} = \sqrt[3]{0.615 * 0.655 * 1.65} = 0.873$$

When comparing the years, it can be seen that the sustainable city index score of Konya is 0.807 for 2019, 0.853 for 2020 and 0.873 for 2021. When this result is evaluated, it is clear that the index score for 2021 increased by 2% compared to the previous year.

5. Discussion

An examination of the calculations stated in the conclusion clearly shows an annual change in the sustainable city index scores calculated based on the indicators of Konya.

Accordingly, Konya's sustainable city index score increased in 2021 compared to the previous year. It can be thought that the value fluctuations in the main dimensions and sub-dimensions depend on the macro and micro environmental factors in the selected years. It can be said that one of the most important reasons for these decreases in value is the COVID-19 pandemic period, which affected the whole world in 2020. This situation can be evaluated in more detail, especially when looking at the main and sub-dimensions in Tables 10 and 11.

Although competitiveness achieved an increase in value in its three-year provision, it is seen that the industry and tourism sub-dimension has a stable course when its sub-indexes are examined. This stable situation can be considered to be a result of the COVID-19 crisis. As stated in the "2022 World Development Report" of the World Bank, the COVID-19 epidemic created shock waves in the world economy and contributed to the biggest global economic crisis in the century. When we look at the items of industry, tourism and trade, which are the sub-dimensions of the main competitiveness dimension, it can be seen that the COVID-19 crisis either directly or indirectly affected those areas. In the sector reports published by the International Labor Organization (ILO), it is stated that the tourism sector stopped completely and that production and employment in many sectors, especially the manufacturing sector, were adversely affected. From the tourism sector perspective, restrictions on the movement of people profoundly affected the tourism economy with serious economic and social consequences for tourism workers and businesses, destinations and the wider ecosystem (OECD, 2022). When it is considered that the indicators that make up the tourism sub-dimension are the number of museum visits and the number of tourists, the connection of the decline in 2020 with the epidemic can be better understood. Situations such as the interruption of activities as a result of the pandemic and the measures taken created a great risk not only in the tourism sector, but also in various other sectors such as supply chain disruptions, pharmaceuticals, chemicals, consumer and packaged goods, automotive and assembly. In addition, for many businesses in the industrial and manufacturing sectors, this situation is described as the worst situation their company has ever experienced. (McKinsey, 2020).

Contrary to the competitiveness dimension, there is a decrease in value in the liveability dimension. Looking at the sub-indexes, it is seen that the main reason for the decrease is the dramatic loss of value in the health sub-dimension. Similarly, the effects of the pandemic can be seen in the background of this loss of value because the health, transportation and education sectors were among those affected by the pandemic (ILO, 2020). In particular, the report published by Deloitte (2020) stated that for the first time in history, a health crisis painfully showed how inseparable health services and the economy have become. The report also states that the COVID-19 pandemic will have a longer-term impact on health systems (Ducarme, 2020). While the COVID-19 pandemic affected all sectors directly or indirectly, the crisis exacerbated the already overburdened health systems in many countries (Haileamlak, 2021). The education sector was a sector affected by the pandemic. The COVID-19 pandemic affected nearly 1.6 billion students in more than 190 countries and across all continents; it created the biggest disruption to education systems in history. The closure of schools and other learning institutions affected 94 percent of the world's student population, including up to 99 percent in low- and middle-income countries (United Nations, 2020). The inequalities that keep millions of children from accessing quality education were exacerbated by the deprivation of services such as nutrition, mental health and psychosocial support and protection provided through schools (UNICEF, 2020). Due to the interruption of face-to-face education, the need to provide an effective learning environment emerged and the education process alternated between virtual, hybrid and face-to-face learning (Dorn et al., 2021). The values of the innovation dimension, one of the main dimensions of the sustainable city index, increased over the years included in this study. While the R&D sub-dimension increased in value over those years, the technology sub-dimension reached a stagnant position in the last year. Advances in technology and R&D, especially in industry 4.0 technologies, also provide incentives. The advances and initiatives in the field of artificial intelligence constitute the milestones that move the index value upwards. Despite major economic difficulties such as the Russian invasion of Ukraine, the COVID-19 pandemic, rising inflation and supply chain strains in the last three years, globally patent applications rose to over 278,000 in 2022, the highest recorded in a single year (United Nations, 2023). Although the pandemic is listed as a negative factor on the sectors, the reverse effect of the pandemic is also seen in the field of technology. COVID-19 accelerated the adoption of digital technologies by several years.

McKinsey's report (2020a) states that the pandemic accelerated companies, customer and supply chain interactions and digitization of internal operations by three to four years.

This is because, with consumers turning to online channels to a significant extent during the pandemic, companies and industries responded quickly to this demand. The same report states that the pandemic also affected the rates of digital product development. Therefore, it is said that this and many other factors take place in the background of the positive progress in the innovation dimension.

6. Conclusion

The aim of this study was to offer a new index proposal for sustainable cities. There is no similar study in the literature. The calculation method of the index study is different from other studies and contributes to the literature with this difference.

The index model developed for sustainable cities consists of the dimensions of competitiveness, liveability and innovation. The competitiveness dimension has three sub-dimensions. These are the sub-dimensions of industry development, tourism and trade. The liveability dimension consists of health, education, transportation/access and social capital sub-dimensions. Innovation dimension consists of R&D and technology sub-dimensions. This proposed index reveals the performance of cities based on competitiveness, liveability and innovation values. In this study, the proposed sustainable city index was tested in Konya as a sample application and its validity was demonstrated. As a result of the index calculations, sustainability scores were calculated for Konya over the dimensions of competitiveness, liveability and innovation. As seen in the results of the article, the sustainable city index reveals the performance value of a city in the determined themes. This performance value can reveal the progress of a city over the years, as well as providing the opportunity to compare between cities. It can also provide a general output about the efficiency and welfare level of the economies of countries as well as cities and can show whether their growth is sustainable. The sustainable city index can be planned to rank the social capital levels of cities/countries by region and to measure the similarity/difference between their development levels. Another contribution of this study is to present proposals that can form the basis of policies and to reveal the key elements for improving the performance of municipalities.

With this study, important steps are taken regarding the more equitable distribution of cities' resources and the sustainability of resources. The study offers ideas about the city to managers, those who will invest in the city and those who live in the city. This study reveals the strengths and weaknesses of cities. Subsequent studies can be carried out to compare other cities in Türkiye and to reveal the situation in the coming years. In this respect, city-based comparisons can be made by calculating the sustainable city index not only for cities in Türkiye but also for cities all over the world.

ORCID IDs of the authors

Turan Paksoy	0000-0001-8051-8560
Mustafa Atilla Arıcıoğlu	0000-0001-6477-832X
Büşra Yiğitol	0000-0002-7846-3393
Aylin Yılmaz Gezgin	0000-0001-5462-8184

REFERENCES

Abella, A., Ortiz-de-Urbina-Criado, M., & De-Pablos-Heredero, C. (2017). A model for the analysis of data-driven innovation and value generation in smart cities' ecosystems, Cities, 64, 47-53, https://doi.org/10.1016/j.cities.2017.01.011

Aihemaiti, A. (2018). "Türkiye'deki Akıllı Şehirlerin Sıralama Modeli", Master Thesis, İstanbul Commerce University Graduate School of Applied and Natural Sciences, Istanbul.

Akdamar, E. (2018). "Akıllı Kentlere İlişkin ISO 37120 Standardı Göstergelerinin Çok Değişkenli İstatistiksel Tekniklerle İrdelenmesi", PhD Thesis, Uludağ University Social Science Institution, Bursa.

Akman, A. Z. ve Arıcıoğlu, M. A. (2019). Şehirlerin rekabetinde sosyal sermayenin önemi üzerine bir araştırma. Karamanoğlu Mehmetbey Üniversitesi Sosyal ve Ekonomik Araştırmalar Dergisi, 21(36), 19-33.

Alaverdyan, D., Kučera, F., & Horák, M. (2018). Implementation of the smart city concept in the eu: importance of cluster initiatives and best practice cases. International Journal of Entrepreneurial Knowledge, 6(1), https://doi.org/10.2478/ijek-2018-0003.

Amin, A. ve Thrift,N. (2002). Cities: Reimagining the Urban. Polity Press, Blackwell Publishers, Cambridge.

Anthopoulos, L. G., & Fitsilis, P. (2014). Smart cities and their roles in city competition: A classification. International Journal of Electronic Government Research (IJEGR), 10(1), 63-77, https://doi.org/10.4018/ijegr.2014010105.

Begg, I. (1999). Cities and competitiveness. Urban studies, 36(5-6), 795-809, https://www.jstor.org/stable/43100350.

Berger, R. (2019). "The Smart City Breakaway, How a Small Group of Leading Digital Cities is Outpacing the Rest", https://www.rolandberger.com/publications/publication_pdf/roland_berger_smart_city_breakaway_1.pdf.

Blancas, F. J., Lozano-Oyola, M., Gonzalez, M., Guerrero, F. M., & Caballero, R. (2011). How to use sustainability indicators for tourism planning: The case of rural tourism in Andalusia (Spain). Science of the Total Environment, 412, 28-45, https://doi.org/10.1016/j.scitotenv.2011.09.066.

Brenner, N. (1998) Global Cities, Glocal States: Global City Formation and State Territorial Restructuring in Contemporary Europe, Review of International Political Economy, Vol.5, No.1, 1998, https://doi.org/10.1080/096922998347633.

Bruneckiene, J., Cincikaite, R. ve Kilijoniene, A. (2012). The specifics of measurement the urban competitiveness at the national and international level. Inzinerine Ekonomika-Engineering Economics, 23(3), 256-270, https://doi.org/10.5755/j01.ee.23.3.1272.

Castells, M. (1989). The Informational City: Information Technology Economic Restructring and The Urban Regional Process, Basil Blackwell, Oxford.

Çoruh, M. (2021). "Çok Kriterli Karar Verme Tekniklerine Dayalı Yeni Bir Kent Dijitalleşme Endeks Hesaplama Modeli Önerisi: Türkiye Uygulaması", PhD Thesis, Sakarya University Graduate School of Business, Sakarya.

CPA-I (2015). City Anatomy:A Framework to support City Governance, Evaluation and Transformation, Available at: https://cityprotocol.cat/wp-content/uploads/2019/07/CPA-I_001-v2_City_Anatomy.pdf (Accessed 15 July 2023)

De Souza Briggs, X. (1997). Social capital and the cities: Advice to change agents. National Civic Review, 86(2), 111-118.

DeFilippis, J. (2001). The myth of social capital in community development. Housing policy debate, 12(4), 781-806, https://doi.org/10.1080/10511482.2001.9521429.

Deloitte (2018). Şehir Mobilite İndeksi. Available at: https://www2.deloitte.com/tr/tr/pages/public-sector/articles/city-mobility-index.html (Accessed 14 July 2023)

Doğan, İ. ve Bakan, İ. (2020). Rekabet Üstünlüğü Sağlamada Şehir Rekabetçiliği. Hitit Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 13(2), 331-351, doi: https://doi.org/10.17218/hititsosbil.763235.

Dorn, E, Hancock, B., Sarakatsannis, J. and Viruleg, E. (2021). COVID-19 and education: The lingering effects of unfinished learning. Available at: https://www.mckinsey.com/industries/education/our-insights/covid-19-and-education-the-lingering-effects-of-unfinished-learning (Accessed 14 July 2023)

Ducarme, T. (2020). What will be the impact of the Covid-19 pandemic on healthcare systems? Available at: https://www2.deloitte.com/fr/fr/pages/covid-insights/articles/impact-covid19-healthcare-systems.html (Accessed 14 July 2023)

Dutta, S., Lanvin, B., León, L. R., & Wunsch-Vincent, S. (Eds.). (2021). Global innovation index 2021: tracking innovation through the covid-19 crisis. WIPO, DOI: https://doi.org/10.34667/tind.44315

EDAM (2016). Türkiye İçin Bir Rekabet İndeksi. Available at: https://www2.deloitte.com/tr/tr/pages/public-sector/articles/city-mobility-index.html (Accessed 5 July 2023)

Eğilmez, M. (2013). GSYH ve Büyüme Hesaplamaları- Türkiye Örneği. Available at: https://www.mahfiegilmez.com/2013/09/gsyh-ve-buyume-hesaplamalar-turkiye.html. (Accessed 7 July 2023)

Ehmke, C. (2008). Strategies for competitive advantage. Western Extension Marketing Committee, 5, 1-8.

EPI (2022). 2022 Environmental Performance Index, https://epi.yale.edu/, (Accessed 14 July 2023).

Erhard, L. (1958). Prosperity through competition. Ludwig von Mises Institute.

Ericsson (2016). Networked Society City Index. Available at: http://mb.cision.com/Public/15448/2245037/93894148bfbf1118.pdf. (Accessed 14 July 2023)

EU (2006) Cohesion Policy and cities: the urban contribution to growth and jobs in the regions. Available at: https://ec.europa.eu/regional_policy/en/information/publications/communications/2006/cohesion-policy-and-cities-the-urban-contribution-to-growth-and-jobs-in-the-regions, (Accessed 5 July 2023)

Giap, T. K., Thye, W. W., & Aw, G. (2014). A new approach to measuring the liveability of cities: the Global Liveable Cities Index. World Review of Science, Technology and Sustainable Development, 11(2), 176-196, https://doi.org/10.12691/ajcea-8-2-1

Giffinger, R., Haindlmaier, G., & Kramar, H. (2010). The role of rankings in growing city competition. Urban research & practice, 3(3), 299-312, https://doi.org/10.1080/17535069.2010.524420.

Gordon, I. (2002). The competitiveness of cities: why ıt matters ın the 21st century and how we can measure ıt?. Cahiers De Laurif N°135, De L'ınstıtut D'aménagement Et D'urbanısme De La Régıon D'ıle-De-France, 33-41.

Haileamlak, A. (2021). The impact of COVID-19 on health and health systems. Ethiopian Journal of Health Sciences, 31(6), 1073, https://doi.org/4314/ejhs.v31i6.1

Harrison, C., & Donnelly, I. A. (2011, September). A theory of smart cities. In Proceedings of the 55th Annual Meeting of the ISSS-2011, Hull, UK.

Huavari, J., Kangasharju, A. & Alanen, A. (2001). Constructing an index for regional competitiveness, Pellervo Economic Research Institute Working Papers, No:44, Helsinki.

Huggıns, R. (2003). Creating a UK competitiveness ındex: regional and local benchmarking, Regional Studies, 37(1), 89-96, https://doi.org/10.1080/0034340022000033420.

Iammarino, S., McCann, P., & Ortega-Argilés, R. (2018). International business, cities and competitiveness: recent trends and future challenges. Competitiveness Review: An International Business Journal, 28(3), 236-251, https://doi.org/10.1108/CR-10-2017-0070

ILO (2020). COVID-19 pandemisi, dünya genelinde, çalışma süreleri ve kazançlarda yıkıcı etki yaratıyor. Available at: https://www.ilo.org/ankara/areas-of-work/covid-19/WCMS_740868/lang–tr/index.htm (Accessed 8 July 2023)

ISO, (2018). Sustainable cities and communities — Indicators for city services and quality of life.

https://www.iso.org/obp/ui/en/#iso:std:iso:37120:ed-2:v1:en

Ivars-Baidal, J. A., Celdrán-Bernabeu, M. A., Mazón, J. N., & Perles-Ivars, Á. F. (2019). Smart destinations and the evolution of ICTs: a new scenario for destination management?. Current Issues in Tourism, 22(13), 1581-1600, https://doi.org/10.1080/13683500.2017.1388771.

Kamal-Chaoui, L., & Robert, A. (2009). Competitive cities and climate change, OECD, https://www.oecd.org/cfe/regionaldevelopment/44232251.pdf, (Accessed at 15 July 2023).

Kitson, M., Martin, R. ve Tyler, P. (2004). Regional Competitiveness: An Elusive yet Key Concept?, Regional Studies. 38(9): 991-999, https://doi.org/10.1080/0034340042000320816.

Lai, C. M. T., and Cole, A. (2023). Measuring progress of smart cities: Indexing the smart city indices. Urban Governance, 3(1), 45-57, https://www.oecd.org/cfe/cities/Smart-cities-measurement-framework-scoping.pdf (Accessed at 16 July 2023).

Lever W.F. ve Turok, I. (1999). Competitive cities: ıntroduction to the review. Urban Studies, 36/1999, (5-6), 791-793,https://doi.org/10.1080/0042098993213, https://www.jstor.org/stable/43100349.

Li, F. X., Wen, X. P., & Yi, S. J. (2014). Numerical Measurement and Data Processing of Air Pollution. Applied Mechanics and Materials, 577, 1219-1222, https://doi.org/10.4028/www.scientific.net/AMM.577.1219

Martens, P., Caselli, M., De Lombaerde, P., Figge, L., & Scholte, J. A. (2015). New directions in globalization indices. Globalizations, 12(2), 217-228, http://dx.doi.org/10.1080/14747731.2014.944336

Mckinsey, (2020). The coronavirus effect on global economic sentiment. Available at: https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/the-coronavirus-effect-on-global-economic-sentiment (Accessed 14 July 2023)

Mckinsey, (2020A). How COVID-19 has pushed companies over the technology tipping point—and transformed business forever. Available at: https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever. (Accessed 14 July 2023)

Mevlana Kalkınma Ajansı, (2023). Konya ilinde öne çıkan istatistikler. Available at: https://www.konyadayatirim.gov.tr/ (Accessed 7 July 2023)

Moulaert, F. (2000). Globalization and integrated area development in European cities. OUP Oxford.

OECD, 2022. OECD Tourism Trends and Policies 2022. Available at: https://www.oecd-ilibrary.org/sites/a8dd3019-en/index.html?itemId=/content/publication/a8dd3019-en (Accessed 14 July 2023)

Olson, E. M., Cooper, R., & Slater, S. F. (1998). Design strategy and competitive advantage. Business Horizons, 41(2), 55-62, https://doi.org/10.1016/S0007-6813(98)90035-0

Parkinson, M., Hutchins, M., Simmie, J., Clark, G. ve Verdonk, H. (2003). Competitive European cities: where do the core cities stand?, Final Report To Core Cities Working Group, European Institute for Urban Affairs.

Paskaleva, K. A. (2009). Enabling the smart city: The progress of city e-governance in Europe. International Journal of Innovation and Regional Development, 1(4), 405-422, https://doi.org/10.1504/IJIRD.2009.022730

Pinochet, L. H. C., Romani, G. F., de Souza, C. A., & Rodríguez-Abitia, G. (2019). Intention to live in a smart city based on its characteristics in the perception by the young public. Revista de Gestão, 26(1), 73-92, https://doi.org/10.1108/REGE-06-2018-0077

Pirenne, H. (2016). Ortaçağ Kentleri (Çev:Şadan Karadeniz), İletişim Yayınları: İstanbul.

Porter, M. (2000). Rekabet Stratejisi, Sektör ve Rakip Analizi Teknikleri, Çev: Gülen Ulubilgen, Sistem Yayıncılık, İstanbul.

Porter, M. E. (1990). New global strategies for competitive advantage. Planning Review, 18(3), 4-14, https://doi.org/10.1108/eb054287.

Porter, M. E. (2001). How Government Matters: Influences on Prosperity, Competition, and Company Strategy. Academy of Management AllAcademy Session, Washington, DC, Aug, 6.

Porter, M. E. (2003). Building the microeconomic foundations of prosperity: Findings from the business competitiveness index. The global competitiveness report, 29-56.

Raines, F.D., 2000, "Playing from Strength", Brooking Review, 18/2000, 3, Summer. Regional Development Working Papers.

Rondinelli, D. A., Johnson Jr, J. H., & Kasarda, J. D. (1998). The changing forces of urban economic development: Globalization and city competitiveness in the 21st century. Cityscape, 71-105, http://dx.doi.org/10.2139/ssrn.156912

Roy, S. (2016). The Smart City paradigm in India: issues and challenges of sustainability and inclusiveness. Social Scientist, 44(5/6), 29-48, https://doi.org/10.1177/23996544211027583.

Schwab, K., & Zahidi, S. (2020, December). Global competitiveness report: special edition 2020. World Economic Forum.

SEGE (2022). https://www.sanayi.gov.tr/merkez-birimi/b94224510b7b/sege

Shen, J. (2004). Urban competitiveness and urban governance in the globalizing world. Asian Geographer, 23(1-2), 19-36, http://dx.doi.org/10.1080/10225706.2004.9684110.

SIEMENS (2012). The Green Cıty Index, Available at: https://assets.new.siemens.com/siemens/assets/api/uuid:cf26889b-3254-4dcb-bc50-fef7e99cb3c7/gci-report-summary.pdf (Accessed 7 July 2023)

Sofronijević, A., Milićević, V., & Ilić, B. (2014). Smart city as framework for creating competitive advantages in international business management. Management: Journal of Sustainable Business and Management Solutions in Emerging Economies, 19(71), 5-15, https://doi.org/10.7595/management.fon.2014.0015.

Solability (2022a). Global Sustainable Competitiveness Index, Available at: https://solability.com/the-global-sustainable-competitiveness-index/the-index/social-capital (Accessed 7 July 2023)

Solability (2022b). Available at: https://solability.com/the-global-sustainable-competitiveness-index/the-index/governance-capital (Accessed 7 July 2023)

T.C. Kalkınma Bakanlığı, (2014). Bölgesel gelişme ulusal stratejisi 2014-2023. Bölgesel Gelişme ve Yapısal Uyum Genel Müdürlüğü, Ankara.

The Sustainable Competitiveness Report (2021). State of The World Report 2021.

TÜİK (2016), İllerde Yaşam İndeksi 2015, 22 Ocak 2016 tarih ve 24561 sayılı Haber Bülteni, Available at: http://www.tuik.gov.tr/PreHaberBultenleri.do?id=24561(Accessed 7 June 2023)

UNICEF (2020). Summary of UNICEF's 2020 Education Results. Available at: https://www.unicef.org/media/102636/file/Global-annual-results-report-2020-goal-area-2-summary.pdf (Accessed 14 July 2023)

United Nations, (2020). Policy Brief: Education during COVID-19 and beyond. Available at: https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/08/sg_policy_brief_covid-19_and_education_august_2020.pdf (Accessed 14 July 2023)

United Nations, (2023) . Patent filings hit a record high in 2022, UN agency reveals Available at: https://news.un.org/en/story/2023/02/1133992 (Accessed 14 July 2023)

URAK (2018). İller arası Rekabetçilik İndeksi, Available at: http://www.urak.org/wp-content/uploads/2019/05/URAK_%C4%B0RE_2018-2.pdf (Accessed 10 July 2023)

Vodafone (2016). Akıllı Şehir Yol Haritası, https://www.vodafone.com.tr/VodafoneBusiness/iot/pdf/akilli-sehir-yolharitasi.pdf

WEF (2023). Fostering Effective Energy Transition 2023 Edition, Available at: https://www3.weforum.org/docs/WEF_Fostering_Effective_Energy_Transition_2023.pdf (Accessed 10 July 2023)

Westwood, A. ve Nathan, M. (2002). "Mancester: Ideapolis? Developing a Knowledge Capital", Work Foundation, Peter Runge House, 3 Carlton House Terrace, London.

WORLDBANK, (2022). Chapter 1. The economic impacts of the COVID-19 crisis. Available at: https://www.worldbank.org/en/publication/wdr2022/brief/chapter-1-introduction-the-economic-impacts-of-the-covid-19-crisis (Accessed 14 July 2023).

How cite this article

Appendix A: Sustainable city index indicators

Topic	Sub-Dimension	Items	Code	Unit
Competitiveness	Industry Development	1. Industrial electricity consumption per thousand people	CI1	Kwh
Competitiveness	Industry Development	2. Number of opened companies per thousand people	CI2	Piece
Competitiveness	Industry Development	3. Number of closed companies per thousand people	CI3	Piece
Competitiveness	Industry Development	4. Employment rate of the industry	CI4	Percentage
Competitiveness	Industry Development	5. Cash loan amount per thousand people	CI5	Thousand TL
Competitiveness	Industry Development	6. Non-cash loan amount per thousand people	CI6	Thousand TL
Competitiveness	Industry Development	7. Import amount per thousand people	CI7	Thousand dollars
Competitiveness	Industry Development	8. Export amount per thousand people	CI8	Thousand dollars
Competitiveness	Tourism	1. Number of museums per thousand people	CT1	Piece
Competitiveness	Tourism	2. Number of movie theaters per thousand people	CT2	Piece
Competitiveness	Tourism	3. Number of theater halls per thousand people	CT3	Piece
Competitiveness	Tourism	4. Number of hotel beds per thousand people	CT4	Piece
Competitiveness	Tourism	5. Number of tourists per thousand people	CT5	Piece
Competitiveness	Tourism	6. Number of museum visitors per thousand people	CT6	Piece
Competitiveness	Trade	1. Saving deposit amount per thousand people	CTR1	Billiontl
Competitiveness	Trade	2. Population per bank branch	CTR2	Percentage
Competitiveness	Trade	3. Other deposits per thousand people	CTR3	Million TL
Competitiveness	Trade	4. Ratio of number of active insured employees to total population	CTR4	Percentage
Competitiveness	Trade	5.Number of work permits given to foreigners	CTR5	Piece
Competitiveness	Trade	6. Ratio of collection of tax revenues to GDP	CTR6	Percentage
Competitiveness	Trade	7. Agricultural production area per capita	CTR7	Decare
Competitiveness	Trade	8. Freight carriage amount per thousand people (at the airport)	CTR8	-
Competitiveness	Trade	9. The amount of house sales per thousand people	CTR9	Piece
Competitiveness	Trade	10. Number of motor vehicles per thousand people	CTR10	Piece
Competitiveness	Trade	11. Number of ATMs per thousand people	CTR11	Piece
Competitiveness	Trade	12. Import value rate per person	CTR12	Ratio
Competitiveness	Trade	13. The amount of cash loans given by banks per thousand people	CTR13	Thousand TL
Competitiveness	Trade	14. Non-cash amount given by banks per thousand people	CTR14	Thousand TL
Liveability	Health	1. Infant mortality rate (per thousand live births)	LH1	Per thousand (‰)
Liveability	Health	2. Number of hospital beds per thousand people	LH2	Piece
Liveability	Health	3. Number of doctors per thousand people	LH3	Piece
Liveability	Health	4. Number of hospitals per thousand people	LH4	Piece
Liveability	Health	5. Births by maternal age group per thousand (15-19/20-24)	LH5	Piece
Liveability	Health	6. Number of nurses per thousand people	LH6	Piece
Liveability	Health	7. Elderly population ratio	LH7	Percentage
Liveability	Health	8. Crude birth rate	LH8	Per thousand (‰)
Liveability	Health	9. The amount of forest area per thousand people	LH9	Hectare
Liveability	Transport	1. Number of cars per thousand people	LT1	Piece
Liveability	Transport	2. Number of buses per thousand people	LT2	Piece
Liveability	Transport	3. Number of domestic passengers per thousand people (aircraft)	LT3	Piece
Liveability	Transport	4. Number of TCDD incoming passengers per thousand people	LT4	Piece
Liveability	Transport	5. Number of TCDD outgoing passengers per thousand people	LT5	Thousand people
Liveability	Transport	6. Number of pickup trucks per thousand people	LT6	Piece
Liveability	Transport	7. Number of mobile broadband subscriptions per thousand people	LT7	Piece
Liveability	Transport	8. Number of fixed broadband subscriptions per thousand people	LT8	Piece
Liveability	Transport	9. Number of fixed telephony access lines per thousand people	LT9	Piece
Liveability	Transport	10. Number of mobile telephony subscriptions per thousand people	LT10	Piece
Liveability	Education	1. Literacy rate	LE1	Ratio
Liveability	Education	2. Number of students in pre-school education per thousand people	LE2	Piece
Liveability	Education	3. Number of students per teacher in primary school	LE3	Piece
Liveability	Education	4. Number of students per teacher in high school	LE4	Piece
Liveability	Education	5. Number of students per teacher in vocational and technical high school	LE5	Piece
Liveability	Education	6. Number of university graduates per thousand people (including master's and doctorate)	LE6	Piece
Liveability	Education	7. Number of academicians per thousand people	LE7	Piece
Liveability	Education	8. Number of students per thousand people (Bachelor + associate degree)	LE8	Piece
Liveability	Education	9. Number of students per thousand people (postgraduate)	LE9	Piece
Liveability	Education	10. Number of foreign university students per thousand people	LE10	Piece
Liveability	Education	11. Enrollment rate (Middle School)	LE11	Percentage (%)
Liveability	Education	12. Enrollment rate (Secondary Education)	LE12	Percentage (%)
Liveability	Education	13. Enrollment rate (Primary school)	LE13	Percentage (%)
Liveability	Education	14. Enrollment rate (Primary education)	LE14	Percentage (%)
Liveability	Education	15. Female enrollment rate (Middle School)	LE15	Percentage (%)
Liveability	Education	16. Female enrollment rate (Secondary Education)	LE16	Percentage (%)
Liveability	Education	17. Female enrollment rate (Primary school)	LE17	Percentage (%)
Liveability	Education	18. Female enrollment rate (Primary education)	LE18	Percentage (%)
Liveability	Education	19. Number of teachers per student	LE19	Piece
Liveability	Education	20. Number of females in university per thousand people (Bachelor+Associate Degree)	LE20	Piece
Liveability	Education	21. Number of females in university per thousand people (postgraduate)	LE21	Piece
Liveability	Education	22. Number of people using the public library per thousand people	LE22	Piece
Liveability	Education	23. Number of graduates per thousand people	LE23	Piece
Liveability	Social Capital	1. Number of convicts per thousand people	LSC1	Piece
Liveability	Social Capital	2. Migration rate	LSC2	Percentage (%)
Liveability	Social Capital	3. Number of convicts per thousand people (crime of murder)	LSC3	Piece
Liveability	Social Capital	4. Number of suicides per thousand people per year	LSC4	Piece
Liveability	Social Capital	5. Number of convicts per thousand people (other crimes)	LSC5	Piece
Liveability	Social Capital	6. Number of legal cases per thousand people	LSC6	Piece
Liveability	Social Capital	7. Youth unemployment rate	LSC7	Percentage (%)
Liveability	Social Capital	8. Divorce rate in one year	LSC8	Per thousand (‰)
Liveability	Social Capital	9. Unemployment rate	LSC9	Percentage (%)
Liveability	Social Capital	10. Traffic accidents in a million population	LSC10	Piece
Innovation	R/D	1. Number of patent applications per thousand people	IRD1	Piece
Innovation	R/D	2. Number of trademark applications per thousand people	IRD2	Piece
Innovation	Technology	1. Domestic patent application rate per thousand people	IT1	Piece
Innovation	Technology	3. Number of research assistants per thousand people	IT2	Piece
Innovation	Technology	4. Number of Instructors per thousand people	IT3	Piece
Innovation	Technology	5. Number of faculty members per thousand people	IT4	Piece
Innovation	Technology	6. Number of investment incentive certificates per thousand people	IT5	Piece

Appendix B: Number of ATMs per thousand people (Code: CTR11)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Adana	0.359	0.407	0.435	0.449	0.450	0.464	0.460	0.456	0.444	0.444
Adıyaman	0.150	0.194	0.227	0.239	0.249	0.249	0.258	0.249	0.256	0.266
Afyonkarahisar	0.305	0.351	0.402	0.426	0.439	0.450	0.453	0.455	0.457	0.456
Ağrı	0.105	0.131	0.146	0.161	0.162	0.168	0.170	0.172	0.181	0.193
Aksaray	0.258	0.311	0.349	0.362	0.345	0.355	0.342	0.351	0.352	0.336
Amasya	0.348	0.401	0.426	0.447	0.469	0.509	0.504	0.485	0.504	0.501
Ankara	0.613	0.680	0.721	0.742	0.742	0.747	0.762	0.735	0.730	0.701
Antalya	0.700	0.785	0.830	0.847	0.834	0.823	0.804	0.807	0.832	0.800
Ardahan	0.216	0.292	0.298	0.332	0.356	0.381	0.384	0.421	0.447	0.442
Artvin	0.485	0.555	0.625	0.659	0.678	0.728	0.701	0.726	0.749	0.773
Aydın	0.541	0.605	0.645	0.708	0.723	0.725	0.710	0.724	0.716	0.682
Balıkesir	0.514	0.571	0.603	0.643	0.642	0.644	0.653	0.662	0.653	0.647
Bartın	0.329	0.386	0.417	0.446	0.489	0.496	0.518	0.520	0.528	0.506
Batman	0.139	0.159	0.169	0.175	0.180	0.190	0.197	0.197	0.195	0.195
Bayburt	0.264	0.317	0.323	0.344	0.311	0.336	0.328	0.306	0.330	0.317
Bilecik	0.465	0.541	0.591	0.593	0.573	0.604	0.604	0.574	0.581	0.565
Bingöl	0.152	0.166	0.177	0.198	0.215	0.212	0.224	0.239	0.259	0.272
Bitlis	0.145	0.169	0.183	0.206	0.214	0.220	0.218	0.224	0.219	0.230
Bolu	0.527	0.593	0.611	0.608	0.630	0.650	0.641	0.617	0.626	0.597
Burdur	0.421	0.470	0.490	0.507	0.520	0.521	0.530	0.532	0.532	0.526
Bursa	0.493	0.550	0.585	0.621	0.641	0.658	0.660	0.646	0.624	0.598
Çanakkale	0.519	0.575	0.647	0.684	0.695	0.692	0.686	0.695	0.691	0.682
Çankırı	0.304	0.340	0.409	0.464	0.473	0.478	0.430	0.470	0.483	0.489
Çorum	0.302	0.355	0.385	0.409	0.405	0.441	0.438	0.446	0.455	0.466
Denizli	0.403	0.476	0.504	0.523	0.532	0.539	0.539	0.534	0.535	0.527
Diyarbakır	0.161	0.191	0.213	0.229	0.227	0.231	0.226	0.224	0.230	0.229
Düzce	0.390	0.424	0.467	0.469	0.478	0.522	0.505	0.505	0.493	0.496
Edirne	0.530	0.645	0.690	0.703	0.729	0.774	0.780	0.773	0.802	0.810
Elazığ	0.236	0.267	0.316	0.338	0.342	0.344	0.344	0.359	0.357	0.364
Erzincan	0.340	0.427	0.461	0.489	0.504	0.518	0.500	0.528	0.516	0.501
Erzurum	0.278	0.333	0.372	0.396	0.399	0.434	0.421	0.415	0.418	0.419
Eskişehir	0.534	0.620	0.687	0.698	0.697	0.720	0.739	0.740	0.730	0.693
Gaziantep	0.236	0.282	0.319	0.336	0.337	0.341	0.334	0.326	0.321	0.321
Giresun	0.336	0.376	0.416	0.438	0.448	0.466	0.474	0.495	0.486	0.500
Gümüşhane	0.288	0.347	0.355	0.376	0.320	0.353	0.363	0.365	0.43	0.4
Hakkari	0.157	0.201	0.206	0.219	0.25	0.243	0.258	0.256	0.26	0.273
Hatay	0.259	0.307	0.338	0.347	0.354	0.357	0.351	0.354	0.345	0.344
Iğdır	0.168	0.2	0.224	0.249	0.265	0.267	0.253	0.256	0.263	0.271
Isparta	0.41	0.486	0.516	0.536	0.55	0.572	0.555	0.578	0.604	0.592
İstanbul	0.65	0.714	0.753	0.765	0.758	0.772	0.785	0.769	0.758	0.73
İzmir	0.612	0.686	0.731	0.747	0.749	0.755	0.759	0.751	0.732	0.707
Kahramanmaraş	0.201	0.251	0.276	0.282	0.296	0.309	0.307	0.307	0.313	0.315
Karabük	0.484	0.56	0.618	0.616	0.631	0.65	0.645	0.648	0.649	0.622
Karaman	0.263	0.34	0.358	0.38	0.399	0.397	0.385	0.387	0.392	0.394
Kars	0.203	0.243	0.27	0.284	0.297	0.323	0.336	0.343	0.358	0.388
Kastamonu	0.364	0.386	0.431	0.451	0.47	0.494	0.501	0.501	0.499	0.498
Kayseri	0.345	0.411	0.464	0.474	0.478	0.495	0.485	0.495	0.487	0.474

Kırıkkale	0.339	0.4	0.428	0.459	0.486	0.513	0.499	0.484	0.495	0.493
Kırklareli	0.525	0.611	0.66	0.718	0.731	0.736	0.712	0.73	0.727	0.715
Kırşehir	0.307	0.331	0.382	0.39	0.4	0.384	0.376	0.387	0.399	0.42
Kilis	0.225	0.226	0.272	0.298	0.329	0.33	0.33	0.344	0.322	0.309
Kocaeli	0.612	0.672	0.709	0.724	0.718	0.719	0.701	0.689	0.663	0.641
Konya	0.283	0.322	0.362	0.375	0.373	0.371	0.365	0.366	0.362	0.357
Kütahya	0.342	0.388	0.420	0.457	0.452	0.472	0.453	0.451	0.447	0.451
Malatya	0.270	0.319	0.361	0.378	0.39	0.397	0.381	0.391	0.385	0.387
Manisa	0.367	0.42	0.452	0.49	0.502	0.522	0.531	0.532	0.521	0.514
Mardin	0.136	0.159	0.175	0.191	0.193	0.189	0.194	0.191	0.201	0.204
Mersin	0.349	0.393	0.441	0.452	0.448	0.454	0.453	0.458	0.452	0.446
Muğla	0.961	1.077	1.169	1.201	1.205	1.207	1.178	1.191	1.177	1.137
Muş	0.114	0.131	0.141	0.159	0.165	0.163	0.169	0.169	0.18	0.19
Nevşehir	0.424	0.466	0.531	0.568	0.547	0.547	0.56	0.568	0.567	0.555
Niğde	0.235	0.282	0.305	0.335	0.341	0.335	0.321	0.339	0.337	0.338
Ordu	0.266	0.293	0.323	0.347	0.366	0.41	0.396	0.414	0.408	0.41
Osmaniye	0.226	0.271	0.304	0.312	0.312	0.328	0.329	0.34	0.317	0.322
Rize	0.463	0.533	0.555	0.614	0.613	0.622	0.597	0.58	0.598	0.631
Sakarya	0.424	0.5	0.522	0.542	0.541	0.563	0.551	0.532	0.534	0.534
Samsun	0.347	0.418	0.463	0.481	0.482	0.489	0.49	0.488	0.487	0.483
Siirt	0.148	0.172	0.204	0.212	0.223	0.234	0.223	0.233	0.233	0.238
Sinop	0.333	0.376	0.401	0.431	0.443	0.444	0.441	0.463	0.48	0.458
Sivas	0.287	0.316	0.363	0.383	0.406	0.435	0.404	0.416	0.425	0.431
Şanlıurfa	0.116	0.142	0.147	0.154	0.161	0.17	0.167	0.166	0.169	0.178
Şırnak	0.139	0.16	0.162	0.165	0.165	0.171	0.179	0.16	0.16	0.161
Tekirdağ	0.562	0.674	0.678	0.651	0.649	0.654	0.637	0.643	0.635	0.618
Tokat	0.27	0.312	0.338	0.357	0.365	0.36	0.371	0.375	0.398	0.398
Trabzon	0.408	0.47	0.499	0.526	0.525	0.538	0.521	0.536	0.535	0.535
Tunceli	0.406	0.468	0.532	0.569	0.572	0.545	0.488	0.52	0.539	0.538
Uşak	0.345	0.418	0.458	0.47	0.466	0.499	0.52	0.51	0.522	0.509
Van	0.129	0.161	0.176	0.19	0.2	0.215	0.214	0.216	0.231	0.244
Yalova	0.529	0.636	0.667	0.717	0.741	0.756	0.713	0.697	0.699	0.67
Yozgat	0.229	0.284	0.326	0.355	0.354	0.373	0.379	0.366	0.37	0.373
Zonguldak	0.434	0.495	0.524	0.535	0.529	0.55	0.539	0.547	0.541	0.522

Appendix C: Number of doctors per thousand people (Code: LH3)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Adana	1.7	1.7	1.8	1.8	1.9	1.8	1.9	1.9	2	2.1
Adıyaman	1	0.9	1	1	1.2	1.2	1.4	1.4	1.5	1.6
Afyonkarahisar	1.4	1.4	1.5	1.4	1.5	1.5	1.5	1.5	1.6	1.7
Aksaray	1.1	1.1	1.1	1	1.1	1.1	1.1	1.2	1.3	1.4
Amasya	1.2	1.2	1.2	1.2	1.2	1.2	1.4	1.3	1.4	1.5
Ankara	3.1	3.1	3.2	3.1	3.1	3.1	3.1	3	3.1	3.4
Antalya	1.9	1.9	2	2	2	2	2	2.1	2.2	2.2
Ardahan	1.3	1.3	1.4	1.2	1.2	1.4	1.5	1.4	1.5	1.7
Artvin	1.4	1.3	1.3	1.2	1.1	1.4	1.7	1.5	1.7	1.9
Aydın	1.6	1.7	1.8	1.8	1.8	1.8	1.9	1.9	1.9	2
Ağrı	0.9	0.8	0.9	0.9	0.9	0.9	1	0.9	1	1.1
Balıkesir	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.5	1.5	1.6
Bartın	1.2	1.2	1.2	1.2	1.3	1.2	1.3	1.2	1.3	1.4
Batman	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.3
Bayburt	1.3	1.3	1.5	1.3	1.4	1.2	1.5	1.4	1.5	1.7
Bilecik	1.2	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.4
Bingöl	1.1	1.1	1.1	1	1	1.1	1.2	1.1	1.3	1.4
Bitlis	1	1	1	1	1.1	1.1	1.3	1.1	1.4	1.4
Bolu	2.2	2.2	2.3	2.4	2.4	2.2	2.6	2.4	2.4	2.7
Burdur	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.5	1.4	1.5
Bursa	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.7	1.7	1.7
Denizli	1.8	1.7	1.8	1.8	1.9	1.8	1.9	1.9	1.9	2
Diyarbakır	1.4	1.5	1.5	1.5	1.6	1.4	1.5	1.5	1.6	1.7
Düzce	1.8	1.7	1.7	1.7	1.7	1.7	1.8	1.7	1.8	1.9
Edirne	2.8	2.5	2.5	2.5	2.6	2.7	2.6	2.9	3	3.1
Elazığ	2.1	2.2	2.1	2	2	2	2.1	1.6	1.7	1.9
Erzincan	1.4	1.4	1.3	1.4	1.6	1.7	1.8	1.8	2	2.1
Erzurum	2	2	2.1	2.1	2.2	2.3	2.1	2.1	2.2	2.3
Eskişehir	2	2	2.1	2.1	2.1	2.1	2.1	2.2	2.3	2.4
Gaziantep	1.3	1.4	1.4	1.4	1.4	1.4	1.5	1.4	1.4	1.5
Giresun	1.3	1.4	1.3	1.3	1.3	1.4	1.5	1.5	1.6	1.8
Gümüşhane	1.3	1.3	1.1	1	1.1	1.1	1.1	1.1	1.2	1.6
Hakkari	1	0.8	0.9	0.7	0.7	0.9	0.9	1	1.2	1.3
Hatay	1.2	1.2	1.3	1.3	1.4	1.3	1.4	1.4	1.5	1.6
Isparta	2.3	2.5	2.6	2.5	2.5	2.4	2.5	2.5	2.6	2.8
Iğdır	1	1.1	0.9	0.8	1.1	1	1	1	1.2	1.3
Kahramanmaraş	1.2	1.2	1.2	1.2	1.2	1.3	1.5	1.4	1.5	1.5
Karabük	1.4	1.5	1.4	1.5	1.6	1.5	1.7	1.7	1.8	1.9
Karaman	1.3	1.2	1.2	1.2	1.3	1.2	1.3	1.3	1.4	1.4
Kars	1.2	1.4	1.4	1.5	1.6	1.6	1.7	1.4	1.8	1.7
Kastamonu	1.4	1.3	1.2	1.1	1.1	1.2	1.3	1.3	1.4	1.5
Kayseri	1.8	1.8	1.9	1.8	1.9	1.8	1.9	2	2	2.1
Kilis	1.2	1.4	1.5	1.5	1.8	1.8	1.8	1.9	1.9	2.2
Kocaeli	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.6	1.6	1.8
Konya	1.7	1.8	1.8	1.8	1.8	1.8	1.9	1.9	2	2
Kütahya	1.2	1.1	1.1	1.2	1.3	1.2	1.3	1.3	1.4	1.6
Kırklareli	1.3	1.3	1.3	1.2	1.3	1.4	1.4	1.4	1.4	1.6

Kırıkkale	2.3	2.4	2.4	2.4	2.4	2.3	2.5	2.2	2.2	2.4
Kırşehir	1.2	1.2	1.2	1.3	1.4	1.4	1.5	1.5	1.5	1.7
Malatya	1.9	1.9	1.9	2	2	2.1	2.2	2.1	2.2	2.1
Manisa	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.7	1.8	1.8
Mardin	0.9	0.9	0.9	0.9	1	1	1.1	1.1	1.3	1.2
Mersin	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.6	1.6	1.6
Muğla	1.4	1.5	1.5	1.6	1.6	1.8	1.8	1.7	1.8	1.8
Muş	1.1	0.9	1	0.9	0.9	1	1	0.9	1.1	1.1
Nevşehir	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3
Niğde	1.1	1	1.1	1	1.1	1.1	1.2	1.2	1.2	1.3
Ordu	1.2	1.2	1.3	1.3	1.3	1.4	1.5	1.4	1.5	1.6
Osmaniye	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3
Rize	1.6	1.4	1.5	1.8	1.8	1.8	2.1	2	2.1	2.2
Sakarya	1.3	1.2	1.2	1.4	1.4	1.4	1.5	1.5	1.6	1.7
Samsun	1.9	1.9	2	2	2.1	2	2.1	2	2.2	2.3
Siirt	1.2	1.2	1.1	0.9	1.1	1.2	1.3	1.1	1.3	1.2
Sinop	1.2	1.2	1.1	1.2	1.2	1.2	1.2	1.3	1.4	1.4
Sivas	1.8	1.8	1.9	1.9	1.9	2	2.1	1.9	1.9	1.9
Tekirdağ	1.2	1.3	1.4	1.4	1.3	1.4	1.4	1.4	1.5	1.5
Tokat	1.4	1.4	1.5	1.5	1.6	1.5	1.6	1.5	1.6	1.7
Trabzon	2.2	2.3	2.3	2.2	2.3	2.2	2.3	2.2	2.3	2.5
Tunceli	1.3	1.3	1.4	1.3	1.5	1.4	1.6	1.7	2	2.1
Uşak	1.2	1.2	1.2	1.3	1.3	1.3	1.5	1.4	1.4	1.5
Van	1.4	1.3	1.3	1.2	1.3	1.4	1.4	1.3	1.4	1.4
Yalova	1.3	1.3	1.4	1.3	1.4	1.4	1.5	1.5	1.5	1.6
Yozgat	1.2	1.3	1.4	1.4	1.4	1.4	1.7	1.5	1.6	1.7
Zonguldak	1.8	1.8	1.8	1.8	1.8	1.8	2	1.7	1.8	1.9
Çanakkale	1.4	1.7	1.7	1.7	1.8	1.9	1.9	1.9	2	2.1
Çankırı	1.3	1.2	1.1	1.2	1.1	1.2	1.4	1.1	1.3	1.5
Çorum	1.2	1.2	1.2	1.2	1.2	1.3	1.4	1.4	1.5	1.7
İstanbul	1.9	1.9	1.8	1.9	2	2.2	2	2.2	2.2	2.5
İzmir	2.2	2.3	2.4	2.4	2.4	2.3	2.5	2.6	2.6	2.6
Şanlıurfa	1	1.1	1.2	1.2	1.3	1.1	1.1	1.1	1.2	1.2
Şırnak	1	0.9	1	0.8	0.7	0.8	0.8	0.9	1.1	1.2

Appendix D: Number of trademark applications per thousand people (Code: IRD2)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Adana	0.755	0.662	0.703	0.67	0.793	0.81	0.963	1.205	1.242	1.58
Adıyaman	0.154	0.176	0.221	0.229	0.21	0.208	0.195	0.395	0.414	0.62
Afyonkarahisar	0.4	0.524	0.551	0.435	0.548	0.52	0.562	0.954	1.082	1.156
Ağrı	0.085	0.073	0.069	0.066	0.095	0.083	0.142	0.174	0.265	0.302
Amasya	0.28	0.286	0.251	0.214	0.3	0.29	0.361	0.608	0.662	0.724
Ankara	1.461	1.492	1.438	1.392	1.568	1.528	1.664	2.188	2.589	2.785
Antalya	1.25	1.375	1.342	1.279	1.456	1.488	1.679	2.05	2.175	2.645
Artvin	0.207	0.206	0.184	0.19	0.253	0.247	0.363	0.283	0.549	0.673
Aydın	0.621	0.566	0.616	0.541	0.717	0.731	0.793	1.079	1.234	1.439
Balıkesir	0.643	0.68	0.747	0.553	0.686	0.713	0.843	1.067	1.226	1.328
Bilecik	0.302	0.381	0.278	0.362	0.46	0.345	0.383	0.48	0.727	0.564
Bingöl	0.102	0.075	0.079	0.115	0.201	0.089	0.139	0.181	0.254	0.297
Bitlis	0.11	0.101	0.059	0.062	0.123	0.086	0.098	0.179	0.17	0.46
Bolu	0.628	0.393	0.508	0.507	0.716	0.6	0.803	0.988	1.022	1.462
Burdur	0.295	0.358	0.302	0.241	0.374	0.374	0.414	0.666	0.811	0.873
Bursa	1.437	1.501	1.47	1.499	1.65	1.608	1.841	2.213	2.508	2.773
Çanakkale	0.725	0.594	0.818	0.685	0.813	0.732	0.874	1.346	1.407	1.639
Çankırı	0.215	0.256	0.232	0.185	0.199	0.217	0.25	0.582	0.478	0.547
Çorum	0.483	0.345	0.35	0.375	0.39	0.352	0.418	0.658	0.745	0.979
Denizli	1.263	1.238	1.353	1.332	1.52	1.32	1.495	2.185	2.307	2.578
Diyarbakır	0.195	0.271	0.216	0.216	0.29	0.296	0.336	0.436	0.473	0.564
Edirne	0.587	0.6	0.534	0.545	0.661	0.556	0.539	0.748	0.92	1.056
Elazığ	0.503	0.408	0.418	0.385	0.524	0.477	0.596	0.697	0.731	0.945
Erzincan	0.327	0.322	0.269	0.314	0.263	0.339	0.311	0.495	0.636	0.652
Erzurum	0.254	0.262	0.249	0.259	0.305	0.242	0.269	0.473	0.4	0.591
Eskişehir	0.94	1.153	0.999	0.923	0.964	1.457	1.19	1.485	1.657	1.877
Gaziantep	1.611	1.563	1.451	1.742	1.743	1.628	1.749	2.103	2.235	2.387
Giresun	0.278	0.277	0.295	0.189	0.334	0.291	0.341	0.53	0.504	0.659
Gümüşhane	0.092	0.137	0.145	0.151	0.182	0.215	0.219	0.346	0.373	0.36
Hakkari	0.084	0.134	0.09	0.067	0.08	0.08	0.071	0.1	0.194	0.127
Hatay	0.508	0.558	0.587	0.57	0.616	0.604	0.657	0.937	0.976	1.222
Isparta	0.539	0.509	0.453	0.573	0.735	0.664	0.733	1.047	1.232	1.531
Mersin	0.584	0.709	0.759	0.771	0.787	0.887	0.993	1.327	1.331	1.504
İstanbul	3.321	3.41	3.151	3.025	3.306	3.257	3.619	4.621	5.025	5.337
İzmir	1.364	1.444	1.592	1.55	1.65	1.542	1.719	2.147	2.556	2.905
Kars	0.093	0.094	0.082	0.1	0.136	0.135	0.147	0.193	0.302	0.364
Kastamonu	0.31	0.241	0.217	0.265	0.258	0.25	0.401	0.486	0.495	0.622
Kayseri	0.976	0.95	1.07	0.971	1.102	1.023	1.101	1.519	1.921	2.055
Kırklareli	0.458	0.396	0.389	0.492	0.393	0.477	0.495	0.669	0.841	1.162
Kırşehir	0.304	0.44	0.248	0.196	0.269	0.442	0.288	0.379	0.473	0.528
Kocaeli	0.901	0.896	0.965	1.06	1.279	1.258	1.085	1.619	1.744	1.953
Konya	1.321	1.184	1.15	1.179	1.308	1.261	1.369	1.881	2.293	2.867
Kütahya	0.454	0.441	0.436	0.371	0.344	0.484	0.433	0.822	0.957	0.963
Malatya	0.413	0.447	0.405	0.358	0.444	0.482	0.505	0.762	0.897	0.994
Manisa	0.455	0.46	0.519	0.485	0.527	0.497	0.718	0.938	0.934	0.924
Kahramanmaraş	0.38	0.343	0.41	0.389	0.411	0.448	0.53	0.711	0.865	0.913
Mardin	0.305	0.243	0.373	0.36	0.501	0.499	0.509	0.713	0.763	0.882
Muğla	0.88	1.108	1.197	1.141	1.103	1.315	1.577	1.866	2.276	2.708
Muş	0.041	0.063	0.076	0.049	0.054	0.059	0.095	0.134	0.175	0.193
Nevşehir	0.659	0.751	0.649	0.574	0.554	0.754	0.98	1.249	1.461	1.497
Niğde	0.21	0.224	0.199	0.302	0.468	0.373	0.444	0.743	1.124	1.349
Ordu	0.197	0.232	0.23	0.213	0.37	0.396	0.357	0.483	0.58	0.888
Rize	0.871	0.667	0.623	0.634	0.767	0.858	0.877	1.185	1.27	1.956
Sakarya	0.688	0.885	0.805	0.909	0.987	0.895	1.005	1.312	1.572	1.754
Samsun	0.501	0.44	0.473	0.471	0.628	0.642	0.636	0.961	1.031	1.328
Siirt	0.073	0.126	0.165	0.102	0.092	0.112	0.16	0.305	0.28	0.359
Sinop	0.235	0.152	0.26	0.346	0.183	0.228	0.362	0.448	0.618	0.575
Sivas	0.345	0.351	0.285	0.264	0.328	0.326	0.338	0.569	0.717	0.912
Tekirdağ	0.642	0.554	0.631	0.712	0.726	0.627	0.709	1.071	1.128	1.275
Tokat	0.194	0.187	0.261	0.173	0.179	0.201	0.238	0.425	0.425	0.588
Trabzon	0.426	0.786	0.716	0.609	0.661	0.727	0.679	0.993	1.009	1.214
Tunceli	0.14	0.196	0.256	0.061	0.182	0.102	0.248	0.348	0.359	0.474
Şanlıurfa	0.208	0.244	0.22	0.212	0.25	0.243	0.328	0.355	0.443	0.56
Uşak	0.392	0.343	0.411	0.348	0.296	0.327	0.472	0.709	0.705	0.975
Van	0.109	0.132	0.149	0.126	0.157	0.147	0.193	0.258	0.332	0.328
Yozgat	0.095	0.104	0.129	0.166	0.148	0.176	0.216	0.566	0.437	0.531
Zonguldak	0.158	0.222	0.18	0.166	0.233	0.227	0.277	0.504	0.507	0.53
Aksaray	0.345	0.299	0.318	0.239	0.398	0.451	0.543	0.69	0.881	1.076
Bayburt	0.145	0.124	0.102	0.055	0.162	0.097	0.212	0.476	0.447	0.51
Karaman	0.979	0.836	1.676	1.063	0.718	0.695	0.829	1.094	1.329	1.545
Kırıkkale	0.273	0.243	0.226	0.291	0.291	0.248	0.357	0.42	0.659	0.747
Batman	0.287	0.176	0.252	0.262	0.354	0.309	0.391	0.524	0.624	0.675
Şırnak	0.101	0.053	0.086	0.074	0.147	0.145	0.142	0.203	0.216	0.316
Bartın	0.402	0.312	0.236	0.255	0.336	0.281	0.237	0.422	0.496	0.649
Ardahan	0.058	0.119	0.101	0.244	0.144	0.091	0.134	0.302	0.274	0.714
Iğdır	0.179	0.161	0.125	0.13	0.154	0.096	0.17	0.228	0.236	0.275
Yalova	0.482	0.547	0.528	0.571	0.681	0.717	0.775	1.119	1.165	1.657
Karabük	0.417	0.532	0.422	0.425	0.552	0.387	0.334	0.53	0.738	0.897
Kilis	0.327	0.342	0.375	0.482	0.44	0.491	0.575	0.567	0.734	0.845
Osmaniye	0.208	0.195	0.189	0.201	0.189	0.219	0.208	0.452	0.517	0.552
Düzce	0.905	0.608	0.563	0.532	0.617	0.557	0.704	1.17	1.222	1.298