



INFORMATION AND COMMUNICATION TECHNOLOGIES DEVELOPMENT INDEX: REGIONAL ANALYSIS OF TURKEY

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ABSTRACT

Purpose - In this study, the ICT development level of Turkey is aimed to evaluate. To this end, ICT development Index (ICTDEV-I) calculated for Turkey-wide and 12 regions from the years of 2013 to 2017 separately for each year. Then, comparative analysis and recent situation analysis are performed.

Methodology - Following the methodology used by the International Telecommunication Union (ITU), Factor Analysis is used and the Principal Component Analysis method is chosen to calculate the ICTDEV-I and to determine the weight of each indicator.

Findings- The regions are ranked according to the calculated index values. ICTDEV-I values of 12 regions are increased within five years.

Conclusion- Within five years, there has not a considerable change in the index ranking of the regions, and many regions have kept their place in the index. Considering the ICTDEV-I values of the regions, while Istanbul has the highest value, the Southeast Anatolia Region has the lowest value.

Keywords: Information and communication technologies, ICT Development Index, region, technology, human capital.

JEL Codes: O12, O33, O34

1. INTRODUCTION

Information and Communication Technologies (ICT) that have a positive effect on the economic and social structures of countries has become an important tool for global, national and regional development. However, the effects of the developments in these technologies on the economic and social structure may differ between regions or countries. These differences are related to the socioeconomic levels of individuals, households, regions or countries and affect the ICT usage and access (OECD, 2001).

In this direction, in a country, it has become necessary to establish a technical infrastructure and an ICT ecosystem to enable each region to benefit from these technologies. Thus economic growth and sustainability through ICT can be provided (Isik, Kilinc, 2013). In order to constitute this system and benefit from ICT at the macroeconomic level, it is necessary to penetrate of ICT to economic and social life as a whole.

In this context, it should be aimed to create a appropriate infrastructure that will enable all regions to make effective use of these technologies instead of having ICT in only certain regions within the country. For this purpose, it may develop a strategy that recognizes and encompasses all segments of society. In this strategy, increasing internet access in public places, to ensuring widespread use of ICT by the private sector, to reducing internet access prices, to integrating ICT into private, public and international sectors, providing adequate distribution of broadband network systems to cities or regions may be taken into consideration. All of these will lead to regional development and increase the level of ICT development of the countries.

Factors such as access to ICT, usage of technology and adequate human capital accumulation are considered as indicators of the development of ICT in an economy (Taban, 2010). Hence, these issues are given importance at the level of national and global. Within this scope, various statistics and reports on ICT are published by international organizations such as UN, OECD, IMF, UNESCO, ITU.

Measuring the Information Society Report is one of these reports that published annually by the International Telecommunication Union since 2009 to monitor the development of countries in ICT and make a comparison between them. In the report, countries are evaluated within the scope of ICT Development Index (ICT Development Index, IDI) which is calculated with three sub-indices as called ICT access, usage, and skills. This sub-indexes are involved 11 indicators. In the index, the ICT development of countries over time is examined globally and regionally and digital differences between them are revealed (ITU, 2017).

In this study, following the methodology used by ITU, the ICT development level of Turkey is aimed to evaluate. To this end, ICT development Index calculated for Turkey-wide and 12 regions (expressed as Level 1) from the years of 2013 to 2017 separately for each year. In this respect, comparative analysis and recent situation analysis are performed.

In the study, considering ICT development of Turkey and its dynamics, aimed to determine which indicators should be given more weight to be used in the index and what stage it is compared to other countries. For this purpose, the economic, social and political infrastructure of Turkey to the creation of appropriate growth models and suggestions are made concerning the determination of corresponding policies.

The rest of the study is organized as follows. A brief review of the empirical literature about the effects of ICT on the countries and regions is provided in section two. The data set and methodology is given in third section. Findings and discussions are mentioned in the fourth section. These sections are followed by the conclusion part.

2. LITERATURE REVIEW

Along with the increasing the share of ICT from national production, many studies in the literature analyze the economic and social effects of ICT on both countries and regions with various methods. As is these studies are in the form of reports prepared by international organizations, it can be in the form of academic studies examining the countries at national and global levels.

Taso et al (2015) calculated the ICT Development Index, annually calculated by the ITU, for 12 regions of Turkey expressed as level 1. They investigated the digital divide between the regions using the years of 2012 data and evaluated the recent situation of the digital divide in Turkey. As a result of their study, they found that there are digitally differences between all the regions of Turkey. They indicated that a crucial digital gap especially among the east and west parts of Turkey.

Malisuwan et al. (2015) considered the dynamics of Thailand proposed a modified model of ICT Development Index (IDI) to bring Thailand to be an ICT leader in ASEAN. In this regard, they determined the weakness points of ICT development in Thailand and found that 5 weak indicators out of 11 weak indicators. They also predicted that Thailand can be the first rank in the ICT development ranking among the ASEAN countries in 2020.

Erdil et al. (2015) considered the current state of the ICT sector in the region of Ankara in Turkey. They aimed to prepare an efficient strategy and policies in terms of regional development. The results of their study, they indicated that the province of Ankara (capital of Turkey) has development potential in the ICT sector.

Katz et al. (2013) composed an index called "Digitalization Index" in their study. In this index, they demonstrated the digital progress of 184 Latin American countries, between the years of 2004-2011. When they creating the index, they used six sub-indexes as ubiquity, affordability, reliability, speed, usability, and skill. They indicated that these sub-indexes contained 24 sub-indicators. They divided the 184 counties into four categories as constrained, emerging, transitional and advanced in the index. Consequently, they found that the Latin American region is relatively fast in increasing the level of digitalization and that there are significant differences between countries. They also stated that the difficulties faced by each of the countries which are divided into four categories in the index are different.

Sen and Akdeniz (2012) considered the digital divides in Turkey from various aspects and they compared the performance of Turkey and OECD countries in ICT usage. They found that despite significant progress of Turkey in the ICT, it's performance remained quite weak versus OECD countries. Furthermore, they indicated that there is a distinct difference in terms of the digital divide in urban and rural regions of Turkey.

Bankole et al. (2011) analyzed the productivity of ICT usage in four regions (SADC, ECOWAS, North and East Africa) that involved 28 countries in Africa, using the data envelopment analysis (DEA). In their study, they aimed to determine which regions are effective in ICT usage and the factors affecting ICT usage. In this sense, they concluded that ICT usage in Africa change among the regions and that the ICT usage is determined by infrastructure accessibility and the cost of ICT services.

3. DATA AND METHODOLOGY

In this study, following the ITU methodology, the level of ICT Development in Turkey-wide and 12 regions of Turkey (express level-1) are aimed to evaluate. To that end, the ICT Development Index calculated for Turkey-wide and 12 regions (level-1) from the years 2013 to 2017 separately for each year. At the result of these calculations, the comparative analysis is made and that evaluated the current situation. The regions considered in the study separated according to the Nomenclature of Territorial Units for Statistics (NUTS). These regions are classified as Istanbul (TR1), West Marmara (TR-2), Aegean (TR3), Eastern Marmara (TR4), Western Anatolia (TR5), Mediterranean (TR6), Central Anatolia (TR7), Western Black Sea (TR8), Eastern Black Sea (TR9), Northeast Anatolia (TRA), Middle East Anatolia (TRB), and Southeastern Anatolia (TRC).

The data used to determine the ICT development of Turkey gathered from "Annual Statistics Bulletin on Provincial Level for Electronic Communication Sector" prepared by Information and Communication Technologies Authority of Turkey (ICTA, 2018) and "Information and Communication Technologies Usage in Households and by Individuals Survey" prepared by Turkish Statistical Institute (TSI, 2013-2017). The data obtained is regulated from 2013 to 2017 for each year separately. As the data gathered from ICTA are published at the provincial level, data are grouped on the basis of NUTS-1 (Level-1).

The data used to determine the ICT Development of 12 regions of Turkey and Turkey-wide and the resources used to reach these data are given in Table 1. Distance to reference measure is used to normalize the data. The reference measure is the ideal value accessible for each indicator (similar to a goalpost). This value is taken as 100 except for the five indicators in the index in order to apply the data in the ICT Development Index at the national or regional level. The weight of each of the 11 indicators that equally weighted by ITU is recalculated using the weighting methods of the ITU. In order to calculate the index and to determine the weight of each indicator, one of the dimension reduction methods, Factor Analysis is used. The Principal Component Analysis is chosen in this analysis. In these methods, the variance explanation percentages and the values of the factor loadings are used to calculate the weight of each of the 11 indicators in the index. The weight of each indicator is calculated according to the results obtained from the factor analysis which explained the relative importance of the indicators in each subgroup (Access, Use, Skills sub-indices) in the index.¹

Table 1: Dataset and Resources

ICT Development Index	Dataset and Resources
ICT Access	
1- Fixed telefon subscriptions per 100 inhabitants	ICTA
2- Mobile-cellular telephone subscriptions per 100 inhabitants	ICTA
3- International internet bandwidth (bit/s) per internet user	ITU
4- Percentage of households with a computer	TSI
5- Percentage of households with internet access	TSI
ICT Use	
6- Percentage of individuals using the internet	TSI
7- Fixed-broadband subscriptions per 100 inhabitants	ICTA
8- Active-mobile broadband subscriptions per 100 inhabitants	ICTA
ICT Skills	
9- Adult Literacy Rate	
10- Secondary gross enrolment ratio	TSI
11- Tertiary gross enrolment ratio	

¹As a result of the factor analysis, the weights of each indicator are calculated following the ITU methodology. First, the component loadings are squared and divided by the share of variance explained by the component. Obtained results are multiplied by the ratio of the variance explained by the component and total variance. Then, the derived weights are rescaled to sum up to 100 to increase comparability (ITU, 2009).

The results obtained from the Principal Component Analysis are given in Table 2.

Table 2: Results of Principal Component Analysis

	Eigenvalues	Share of variance explained (%)	Cumulative share of variance explained (%)
ICT Access			
Component 1	3.986	79.721	79.721
Component 2	0.591	11.824	91.546
Component 3	0.287	5.737	97.282
Component 4	0.085	1.691	98.973
Component 5	0.051	1.027	100.000
KMO / Bartlett's Test	0.71 / Ch-Sq (49.568)	(p-value = 0.000)	
ICT Use			
Component 1	2.719	90.618	90.618
Component 2	0.230	7.678	98.296
Component 3	0.051	1.704	100.000
KMO / Bartlett's Test	0.73 / Ch-Sq (31.551)	(p-value = 0.000)	
ICT Skills			
Component 1	2.686	89.517	89.517
Component 2	0.206	6.857	96.374
Component 3	0.109	3.626	100.000
KMO / Bartlett's Test	0.75 / Ch-Sq (25.776)	(p-value = 0.000)	

The results obtained from Factor Analysis for 12 regions, the calculated weights for each indicator, and ideal values are given in Table 3. The data of the 10 indicators in Table 3 are obtained from TSI and ICTA. Because the data is not available for the remaining indicator (International Internet Bandwidth (bit/s) per internet users), the data related to this indicator is obtained from Turkey's ICT Development Index value in the ITU "Measuring the Information Society" reports between the years 2010-2016.

In this respect, the ICT Development Index value of the 12 regions calculated by using the ideal values applied in the normalization process of the data and the weights calculated in Table 3. In the calculation of the final index, following the ITU methodology, equal weight is given to each of the sub-indices of ICT access and ICT usage as 40%. Because ICT skills sub-index is based on the proxy indicators, the weight is given as 20% for this indicator. In the final stage, the weights of the sub-indices are collected and the index value of each region is calculated.

Table 3: Component Loadings and Weights for Indicators Used to Compute ICT Development Index of 12 Regions (Level-1)

	Component Loadings	Ideal Value	Indicator Weights (%)	%
ICT Access				
1- Fixed telephone subscriptions per 100 inhabitants	0.838	25	0.19	40
2- Mobile-cellular telephone subscriptions per 100 inhabitants	0.965	120	0.23	
3- International internet bandwidth (bit/s) per internet user	0.840	4.83	0.17	
4- Percentage of households with a computer	0.922	100	0.22	
5- Percentage of households with internet access	0.892	100	0.20	
ICT Use				
6- Percentage of individuals using the internet	0.965	100	0.34	40
7- Fixed-broadband subscriptions per 100 inhabitants	0.972	20	0.35	
8- Active-mobile broadband subscriptions per 100 inhabitants	0.917	100	0.31	
ICT Skills				
9- Adult Literacy Rate ²	0.963	100	0.35	

²The adult literacy rate indicator is used instead of the mean years of schooling ratio since the differences between regions are thought to be better expressed.

10- Secondary gross enrolment ratio	0.934	100	0.32	20
11- Tertiary gross enrolment ratio	0.940	100	0.34	

When calculating the index value of the regions, the indicator values of the regions are divided into ideal values and multiplied by the weight of each indicator. The obtained values are collected and are multiplied by the weights of each sub-index. Then, the obtained values for each sub-index are collected and are multiplied by 10. Thus, the index value of a region is found.

ICT Development Index of Turkey-wide is created utilizing weights calculated for the 12 regions as expressed Level 1 between the years 2013-2017. The data of Turkey-wide is obtained from the TSI and ICTA and organized separately for five years. The organized data of Turkey-wide for the years 2013-2017 are given Table 4 as comparatively.

Table 4: The Organized Data of Turkey-wide for the years 2013-2017

Turkey-wide		
ICT Access	2013	2017
1- Fixed telephone subscriptions per 100 inhabitants	17.68	13.66
2- Mobile-cellular telephone subscriptions per 100 inhabitants	90.86	96.40
3- International internet bandwidth (bit/s) per internet user	4.81	4.83
4- Percentage of households with a computer	49.90	56.60
5- Percentage of households with internet access	49.10	80.70
ICT Use		
6- Percentage of individuals using the internet	48.90	66.80
7- Fixed-broadband subscriptions per 100 inhabitants	10.95	14.76
8- Active-mobile broadband subscriptions per 100 inhabitants	31.53	70.47
ICT Skills		
9- Adult Literacy Rate	95.40	96.18
10- Secondary gross enrolment ratio	83.67	87.17
11- Tertiary gross enrolment ratio	16.21	21.75

4. FINDINGS AND DISCUSSIONS

ICT Development Index values of 12 regions among the years of 2013-2017 are given in Table 5 comparatively. It is seen that, among the years of 2013-2017, ICT Development Index values of all regions included in Level-1 increased. However, within five years, there is no considerable change in the index ranking of the regions, and many regions have maintained their place in the index ranking. In this period, while Istanbul Region (TR1) index value is 7.41 in 2013, this value reached 8.70 in 2017. Thus, Istanbul has the highest ICTDEV-I value in the 12 regions both the years 2013 and 2017. The provinces such as TR5, TR4, TR3 regions where Ankara, İzmir, Eskisehir, Bursa, and Kocaeli are located follow the region of Istanbul.

Table 5: ICT Development Index (ICTDEV-I) Values for 12 Regions (Level-1)

Regions		2017 Rank	ICTDEV-I 2017	2013 Rank	ICTDEV-I 2013
TR1	Istanbul	1	8.70	1	7.41
TR5	Western Anatolia	2	7.60	2	6.21
TR4	Eastern Marmara	3	7.08	3	5.86
TR3	Aegean	4	7.04	5	5.48
TR2	West Marmara	5	6.90	4	5.65
TR6	Mediterranean	6	6.64	6	4.83
TR8	Western Black Sea	7	6.42	8	4.76
TR7	Central Anatolia	8	6.38	9	4.74
TR9	Eastern Black Sea	9	6.34	7	4.83
TRA	Northeast Anatolia	10	5.31	10	3.76
TRB	Middle East Anatolia	11	5.19	11	3.42
TRC	Southeastern Anatolia	12	5.09	12	3.34

Considering the data brought to the level of NUTS-1, it can be said that the mobile-cellular telephone subscriptions per inhabitants, percentage of households with internet access, percentage of individuals using the internet, and active mobile broadband subscriptions per inhabitants are increased in almost all regions notably TR1 (Istanbul) in five years.

Among these indicators, the increase in mobile broadband subscription in all regions are remarkable. While the index value of this indicator is 29.47 in 2013, it is increased 66.95 in 2017. In this case, it can be concluded that networks are expanded to almost cover the entire population and that have high-speed networks and broadband services, especially in certain regions.

It is observed that there are differences in the fixed telephone subscriptions among the regions and there are serious decreases especially between from the West Regions to the Eastern Regions in this indicator. This decline in fixed telephone subscription is reduced the number of subscribers per person and obstructed the expansion of fiber optic broadband and fixed broadband (UCTEA, 2016). In the index, compared to other indicators, this indicator has a lower value and the difference between regions supports this result.

It is seen that the Southeast Anatolia Region (TRC) has the lowest value in the index. Inter-regional socio-economic factors are effective in differences that in the index values between the east and west of Turkey. Access to ICT and usage of these technologies is further in Western regions depending on the income level, educational status, and population density. The fact that the infrastructure in these regions is more developed than in the eastern regions is also effective in this difference.

The increase in the average index values of the regions between 2013-2017 is shown in Table 6. In this respect, the average of ICTDEV-I of 12 regions increased from 5.02 to 6.56 in five years and increased by 23.48%.

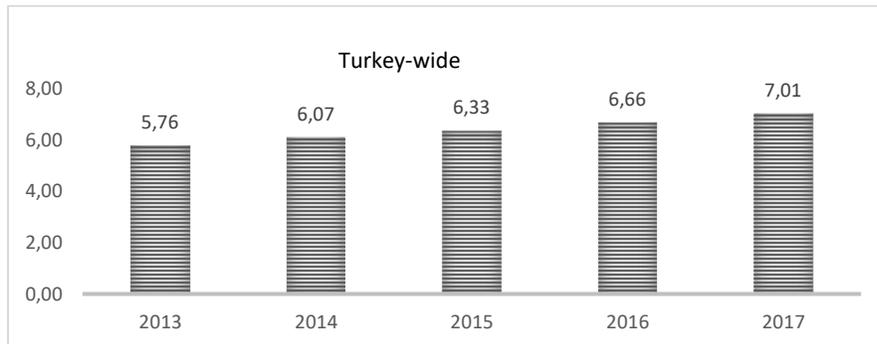
Table 6: ICTDEV-I of 12 Regions (Level-1) and Change Values of the Sub-Indices between the Years 2013-2017

ICTDEV-I of 12 Regions (Level-1)	Average Value	Average Value	Change in Average Value in 2013-2017	
	2013	2017	Difference	%
ICTDEV-I	5.02	6.56	1.54	23.48
Access sub-index	6.24	6.48	0.24	3.85
Use sub-index	3.08	6.52	3.44	111.7
Skills sub-index	6.46	6.78	0.32	4.95

Considering the average changes in the sub-indices, within five years, the access sub-index is 3.85%, the use sub-index is 111.7%, skill sub-index is increased by 4.95%. In this period, the average value of the use sub-index increased faster than the other two sub-indices. Especially increases in mobile broadband penetration and individuals using the internet have an important place among the reasons for this increase. Mobile broadband penetration and an increase in mobile devices lead to more efficient internet access and use.

The skill sub-index increased less than the other two sub-indices, as previously mentioned, the indicators that make up this sub-index consist of proxy indicators and less weight than the other two sub-indices (20%). In addition to this, the fact that the education indicators tend to act more slowly than the indicators in the access and use sub-indices also explains that the average value of this index is lower than the other two indices.

ICT Development Index of Turkey-wide is composed by utilizing the weights calculated for the regions of Level-1 between the years 2013-2017. The ICT Development Index value of Turkey-wide increased from 5.76 in 2013 to 7.01% in 2017 and showed an increase of 21.70% within five years.

Figure 1: ICTDEV-I Value of Turkey-wide, 2013-2017

Considering the data organized for Turkey-wide, it is seen that, mobile phone subscriptions value which is one of the five indicators that in ICT access sub-index is higher than the other indicators (Table 4). This indicator that has a higher value according to the other five indicators affects the ICT use and ICT skills sub-indexes in Turkey positively. The number of young population with the skills to use new technologies in Turkey also supports this conclusion. However, telecommunications services are offered to consumers at relatively affordable prices in Turkey that has a relatively large telecommunications market. Operators support the ICT use and ICT access through various campaigns for different segments notably young people, students, public officials, or retirees, and contribute to the development of the ability to use these technologies. In the ICT access sub-index, the increases in the percentage of households with internet access indicator in five years appear to be remarkable. The indicator value increased from 49.10 in 2013 to 80.70 in 2017, representing an increase of 64.36% (Table 4). This increase in the five-year period means that infrastructure investments for internet access are given importance.

In the ICT usage sub-index, the value of mobile broadband subscriptions per 100 inhabitants increased from 31.53 in 2013 to 70.47 in 2017, representing an increase of 123.50%. Among the reasons why this indicator is higher than the others, firstly, the 3G services launched in 2009, high-speed internet (Long Term Evolution; LTE) launched in 2016, and the rapid growth in the mobile bandwidth market that represents the capacity of network speed used, and expansion of networks to cover almost the entire population can be demonstrated.

Although the rate of fixed-broadband subscriptions per inhabitants in the ICT use index is lower than the others, Turk Telecom that is the market leader and has the largest fiber infrastructure continues to expand and investments. In addition, most of the fixed broadband connections can be implemented via XDSL with a growing number of fiber and cable subscriptions (ITU 2017:2).

5. CONCLUSION

In this study, following the ITU methodology, the level of ICT Development in Turkey-wide and 12 regions of Turkey (express level-1) are aimed to evaluate. To that end, the ICT Development Index calculated for Turkey-wide and 12 regions (level-1) separately for each year from the years 2013 to 2017. As a result of these calculations, the comparative analysis is made and that evaluated the current situation.

According to the results of the analysis, ICT Development Index values of all the regions included in Level-1 is increased between the year 2013-2017. In this respect, the ICT Development Index average of the 12 regions is increased by 23.48% in five years. However, it can be said that, within five years, there is no considerable change in the index ranking of the regions, and many regions maintained their place in the index ranking.

In Turkey, information technology levels that are affected by the factors such as household income, age, gender, education level, occupation, settlement, and the use of these technologies is decreasing by going from the urban to rural areas and from west to east. The use of household information technologies also increases due to increases in education and income levels (Selim, Balyaner, 2017).

Turkey with high growth potential has the latent to increase the ICT share in this growth. The presence of a relatively large telecommunications market; the increase in the number of broadband subscribers and data communication traffic with 4.5G technology, which is becoming widespread in 2016; the length of the fiber optic cable across Turkey increased by 54% between

2012-2017 to reach 325 thousand km (ICTA, 2016); preparation of Information Society Strategy and Action Plans; and the young population with the ability to use new technologies have an impact on this potential.

Turkey should increase its investments towards these technologies so as to cover all the regions in order to increase its existing potential and to reach the level of developed countries in ICT. Nevertheless, it should be increased the share of ICT, R&D, and especially education in GDP.

In order to ensure access to ICT and the widespread and equally use of these technologies in all regions decreasing the costs such as the communication expenses, internet services, lowering the cost of devices such as mobile phones, tablets, computers, and reducing the taxes on ICT services and devices will affect the level of ICT development positively.

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