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Spatial Pattern of Digital Divide in Turkey

Turgay Kerem Koramaz, Somaiyeh Nasrollahzade, Zeynep Ozdemir

(Assoc. Prof. Turgay Kerem Koramaz, Istanbul Technical University, Faculty of Architecture, Department of Urban and Regional Planning, Taskisla, Taksim, 34437, Istanbul, koramaz@itu.edu.tr)
(Somaiyeh Nasrollahzade – PhD Candidate, Istanbul Technical University, Graduate School of Science, Engineering and Technology, Department of Urban and Regional Planning, Taskisla, Taksim, 34437, Istanbul, e- s.nasrz@yahoo.com.tr)
(Res. Assist. Zeynep Ozdemir, Istanbul Technical University, Faculty of Architecture, Department of Urban and Regional Planning, Taskisla, Taksim, 34437, Istanbul, zeynepozdemir37@gmail.com)

1 ABSTRACT

Digital divide, which highlights the access to, use of and skills for information and communication technologies in a regional discrepancy reasoning, is a new field of research, measuring spatial associations in urban and regional studies. In lierature, the emergence of, and formation behind the digital divide concept have been associated with absence of hardware, financial and infrastructural deficiencies, barriers of becoming online and use of technology. Especially with the leading international conventions related to telecommunication networks, technology and innovation associations, the literature stresses the necessity to investigate different domains of this issue, advocating the right of access to technology in favour of disadvantaged geographies and communities.

In the late 1990s, owing to the proliferation of digital divide, the growing gap between different groups who are imparted from new information services and those who are not, became more significant and obvious than in former initial studies. This issue has increased in importance among different parties, such as policy makers, scholars and advocacy groups, in relation to their different roles, varying from supply of technology infrastructure and affordability of obtaining related services. The most significant aspects cited in empirical research are inequality in obtaining new services of information and inequality in patterns of getting access to information technology, akin to regional discrepancies in conventional studies. Especially in Turkey, many scholars studied the divide concept in terms of descriptive statements and few of them undertook exploratory investigations of conventional statistics, neglecting geographical tendencies and spatial autocorrelation effect.

Spatial pattern, as associated with the digital divide concept in this paper, is primarily investigated with officially published parameters related to household profile and technology use. However, this fundemantal field of regional science needs comprehensive and focused understanding of changing barriers to, and attributes of affordability and access to technology by communities. This study aims to depict the spatial pattern of the digital divide phenomena in Turkey, in an index comprised of variables of access to, use of and skills of information and communication technologies. Since the spatial function of digital divide research is mainly missing in conventional studies in Turkey, this paper investigates the spatial associations with the digital divide in the officially published figures and statistics of information and communication technology. In the paper, spatial association is established through Getis and Ord G statistics, with the measure of provincial highway distances, instead of operational uses of Euclidian distances that commonly licenced geographic information systems may offer.

Preliminary findings indicate that spatial autocorrelation and clustering methods show the significance of mono-centric development pattern of Turkey, whereby most populated and in-migrated provinces also dominate in all domains of access to, use and skills of technology. Although figures from officially published data depict spatial heterogeneity superficially, the results of this study indicate the importance and necessity of a prospective comprehensive social survey, with high level of representation capability and spatial sampling. This paper presents also primer investigations of further research, which will compare Istanbul province, as the dominant province with unprivileged provinces in terms of socio-economic development and technology use and supply.

Keywords: digital divide, spatial association, Turkey, spatial correlation, ICT

2 DIGITAL DIVIDE CONCEPT IN LITERATURE

In the same decade of emergence and spread of the first computer microprocessors (Perez, 2002), both information and telecommunication technologies gained dominance in economy and society and the concept of “information gaps”, as their aftermath, has become one of the principal debate related to these

developments. The division of world population into groups of inequality, "information elite" and "information ignorant," is observed as one of the concerns of networked societies (Fong, 2009; van Dijk, 2006; Wilson, et. al., 2003).

In this regard, the term of "digital divide" was raised by Larry Irving, Jr, former US assistant secretary of commerce for telecommunication (Dragulanescu, 2002; Wilson et al., 2003) for the first time as a mainstream political topic in the US at the beginning of 1990s. The idea of "digital divide", as a new form of social inequality (Korupp, 2006; Ragnedda and Muschert, 2013) has increased in relevance by the end of the decade. Several definitions were produced for this concept, but the conventional one in the political agenda is "existing gap in access to information services between those who can afford to purchase the computer hardware and software necessary to participate in the global information network, and low-income families and communities that cannot (Dragulanescu, 2002, p. 139)". However, the term extended its context into a broader understanding as an entire "information and technology gap, inequities and poverty (Dragulanescu, 2002, p. 140)", covering international and regional scales (Wilson et al., 2003; van Dijk, 2006; Fong, 2009).

The digital divide term was initially defined as technological gap, in terms of access to, and usage of information and communication technology (ICT). Then, it has taken a broader perspective, which focuses on social stratification due to unequal ability to access, adapt, and produce skills and knowledge using information technologies (Andearsson, 2012). Unequal ability to access also refers to digital skills derived from differences in household's socio-economic levels in the intellectual agenda. Later the term encompassed other ICT tools, such as mobile devices and services in addition to access to telecommunication networks.

According to empirical studies, different categories have been established, while considering the multi-dimensionality of the digital divide term (Ragnedda and Muschert, 2013). Theoretically, the term distinguishes two levels, the first level is dealing with problems of "access" to computer and internet, and the second level is focusing on user "profiles", for instance how and for what sort of purposes the internet is used (Korupp, 2006). Wilson (2004) in his study propounded eight aspects of digital divide as physical access, financial access, cognitive access, design access, content access, production access, institutional access, and political access. Physical access to personal computers and the internet was the primary aspect in digital divide studies. So physical access appropriated the largest part of digital divide research to itself among demographical categories (van Dijk, 2006).

When interpreting the individual barriers of digital divide, demographical categories are observed frequently as widening digital divide factors at "individual" and "household" scales. The following factors are also commonly used in digital divide research, such as age, gender, education (correlated with digital literacy and intelligence), income, houshold types, disadvantaged groups (mostly based on race and disability status) and locations within a city, country, or region (Emmanouil, and Alexandropoulou-Egyptiadou, 2009; van Dijk, 2006; Acilar, 2011; Cooke and Shuttleworth, 2017). The abovementioned factors have all significant effect on the variance of access to information and communication technologies (Ragnedda and Muschert, 2013). Since these factors are not the same for each country in the world, it can be said that some of them are of low or even neglected importance for the country concerned.

3 SPATIAL PATTERN AND AUTO-CORRELATION OF DIGITAL DIVIDE

Since this paper discusses the term of digital divide, one of the significant components of the digital divide are the association between spatial variances and the discrepencies of access, use, and skills related issues. The examination of spatial auto-correlation in digital divide may be necessary for a better interpretation of spatial associationhips, besides descriptive findings. Spatial auto-correlation can be defined as a measure of the spatial distribution of any attitude or phenomenon whose existence or causal behaviour has a degree of neighbouring effect. In brief, spatial auto-correlation is related to the degree to what extent objects or activities in space approximate to others in their vicinity (Goodchild,1986). Spatial auto-correlation, can be interpreted as a revolution in understanding space. In his research about the Detroit City growth model, published in 1970, Tobler (1970, p.236) stated that "everything is related to everything else, but near things are more related than distant things". Since this quote has been referred to as the first law of geography, further empirical research highlighted the importance of locational allocation and spatial auto-correlation, achieving significant contributions to varying fields in modern geography (Hodgart, 1978; Handler, 1979; Haynes and Fotheringham, 1984).

In spatial statistics, there are many possible ways of measuring spatial auto-correlation by various methods. The most common uses of spatial auto-correlation in both natural and social sciences, can be listed as Moran's I statistic, Geary's C statistic, and the spatial cross-correlation statistic (Moran, 1948; and 1950) and local spatial autocorrelation is measured by Gi* statistics (Getis and Ord, 1992; Ord and Getis, 1995) and Anselin Local Moran's I statistics, (Anselin,1995). In this paper, spatial associationship of digital divide in Turkey is examined by the use of Getis-Ord Gi* Statistics which was developed by the American geographer Arthur Getis and the English statistical and computer scientist J. Keith Ord. Getis-Ord Gi* Statistics of overall spatial association can be given as below (Url-1):

$$G_i^* = \frac{\sum_{j=1}^{n} w_{ij} x_j - \bar{x} \sum_{j=1}^{n} w_{ij}}{s \sqrt{\frac{\left[\left(n \sum_{j=1}^{n} w_{ij}^2 \right) - \left(\sum_{j=1}^{n} w_{ij} \right)^2 \right]}{n-1}}}$$

where, n: is equal to the total number of features; xj: is attribute value for point j; wij: the spatial weight value between point i and j; and : indicates the mean value of the variable. Then S is computed as:

$$S = \sqrt{\frac{\left[\sum_{j=1}^{n} x_j^2 \right]}{n} - (\bar{x})^2}$$

Calculated Getis-Ord Gi* local statistics have a normal distribution and the calculated value is z-statistic values. Getis-Ord Gi* local statistics can be conducted via The Hot Spot Analysis tool in ArcGIS Pro. For statistically significant positive z-scores, the larger the z-score is, the more intense the clustering of high values (hot spot). For statistically significant negative z-scores, the smaller the z-score is, the more intense the clustering of low values (cold spot) (Url-1). Output of the analysis can map both z-scores (standard deviations) and p-values (measure of probability) for the selected features, which represent the statistical significance of clustered values in hot and cold spots, in their spatial associationship.

Since 2000 in the first period of empirical studies on digital divide determinants of telecommunication network, influence of internet use, innovation and technology, investments effects on digital divide have been analysed in empirical model. Even though these models refer to spatial flow of innovation and technological developments, theoretical models may not provide any investigations on spatial auto-correlation (Pick, et al. 2015). Pick et al. (2015) produced a detailed literature summary on the evolution of theoretical models, investigating digital divide. Pick and his colleagues examined the digital divide concept at the international level and in the United States and Japan, in a series of publications (Pick and Azari, 2008; Pick and Nishida, 2015; Pick, et. al, 2015; Nishida, et al, 2015). These studies analysed the technology use variances and digital divide issues with empirically models, additionally screening the spatial auto-correlations of model errors. This paper aims to investigate the digital divide in Turkey by establishing a descriptive index about information and communication technology development levels, as a distinct study from empirical analyses in literature (Guvel and Aytun, 2009; Ozkan ve Celik, 2018; Rencber, 2018), to reveal spatial patterns and auto-correlation of the digital divide in Turkey.

4 DIGITAL DIVIDE IN TURKEY

This paper is part of a comprehensive ongoing research project, entitled Spatial Segregation of Housing Preferences and Technology Use of Households in Turkey (Project Code: MGA-2018-41493; Istanbul Technical University, Scientific Research Office). One of the objectives of the project (highlighted in this paper) is to investigate the capacity of households in Turkey to access information and use of technology over communication channels. In order to target this objective an information and communication development index is established to depict the spatial variances of the digital divide in Turkey.

This paper investigates the digital divide concept at the country level, via existing literature, and internationally recognised principles and measurement standards. ITU - International Telecommunication Union, published a database, covering the relevant indicators for the capacity of households and individuals to use information and communication technologies between 2012 - 2016 (Url-2). One of the performance indicators of this database is the percentage of households with Internet access. Ranked 40th among 120 countries Turkey declared to have 76.3 % of households with internet access in 2013, while the overall global average was 57.0% in these statistics. However, the same rates of individuals with internet access may

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have lower rates of access than households in the world. The data for the same period indicates that overall 62.37% of individuals in the world have internet access, but 58.3% in Turkey. These figures indicate the necessity to examine how the level of technology use is distributed throughout the entire society, as there may be spatial and/or regional discrepancies in proportional quantities in accessing communication technologies, especially the internet.

In addition to technology statistics, ITU - International Telecommunication Union also produces studies to establish a development index for information and communication technologies. According to the latest data for 176 countries, updated on November 20, 2017, IDI (Information and Communication Technologies Development Index) ranged from 8.98 (Iceland) to 0.96 (Eritrea) for 2017. In this ranking, Turkey ranked 72nd with an index score of 5.66 in 2016, and rose to 67th with a score of 6.08.

The Information and communication technologies development index (IDI, by International Telecommunication Union, since 2009) has been framed with three sub-indices and 11 indicators (Url-3). These components and indicators are:

a) ICT infrastructure and access indicators

(1) Fixed-telephone subscriptions per 100 inhabitants

(2) Mobile-cellular telephone subscriptions per 100 inhabitants

(3) International Internet bandwidth (bit/s) per Internet user

(4) Percentage of households with a computer

(5) Percentage of households with Internet access

b) ICT usage indicators

(6) Percentage of individuals using the Internet

(7) Fixed-broadband subscriptions per 100 inhabitants

(8) Active mobile-broadband subscriptions per 100 inhabitants

c) ICT skills indicators

(9) Mean years of schooling rate

(10) Secondary gross enrolment ratio

(11) Tertiary gross enrolment ratio.

4.1 ICT Development Index in Turkey

Investigation of the digital divide in Turkey is assumed to reflect the variances of regional development levels. In the context of the monocentric growth pattern of Turkey with Istanbul as its most populated province the paper attempts to evaluate access to, and use of informationa and communication technology infrastructure at provincial level. For this purpose, data published online by Information Technologies and Communications Authority at provincial level (Url-4) on digital patterns is used. However, some data at provincial level based on the indicator of "3 – International Internet bandwidth (bit/s) per Internet user" could not be ascertained.

For 81 provinces in Turkey, an ICT development index is computed, weighting each of the 10 variables listed above (Fig. 1). According to this distribution, İstanbul has the highest value with 9,646, followed by Ankara which with 8,245 has the second value. Eskişehir and İzmir are following as the third and fourth provinces with an index score above "7". In the fourth interval of the histogram (Fig. 1) Yalova, Kocaeli, Bursa, Muğla, Çanakkale, Antalya, Bolu and Bilecik provinces exist with an index score between 6.00 – 6.99.

There are variances in the scores of sub-indices (ICT access, ICT usage and ICT skill) which overall constitute the ICT development index. For example, İzmir and Antalya have decreased to the 15th and 21st ranks in the ICT access component, although they are located in 5th and 9th ranks in ICT development index, respectively. While ICT development index is 5.965 in Amasya, use of ICT has risen to 5th rank with 6.669 in its sub-indice score. Similarly, ICT development index value (38th) in the Kilis province is 5.013, but use of ICT sub-indice score has increased to 11th rank with a value of 5.84. Due to the higher education levels in the ICT capabilities component, Tunceli province is ranked 5th with a score of 7.522 and Karabük and Isparta

provinces are up to 10th and 12th with 7.075 and 6.990, but these provinces ranked in 49, 31 and 25 for ICT development index. It shows that the provinces which differ in these distributions are due to differences in demographic and socio-economic levels.

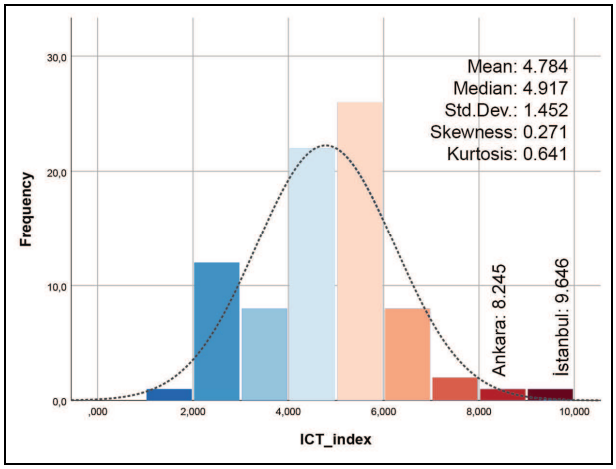

Fig. 1. ICT development index of provinces in Turkey

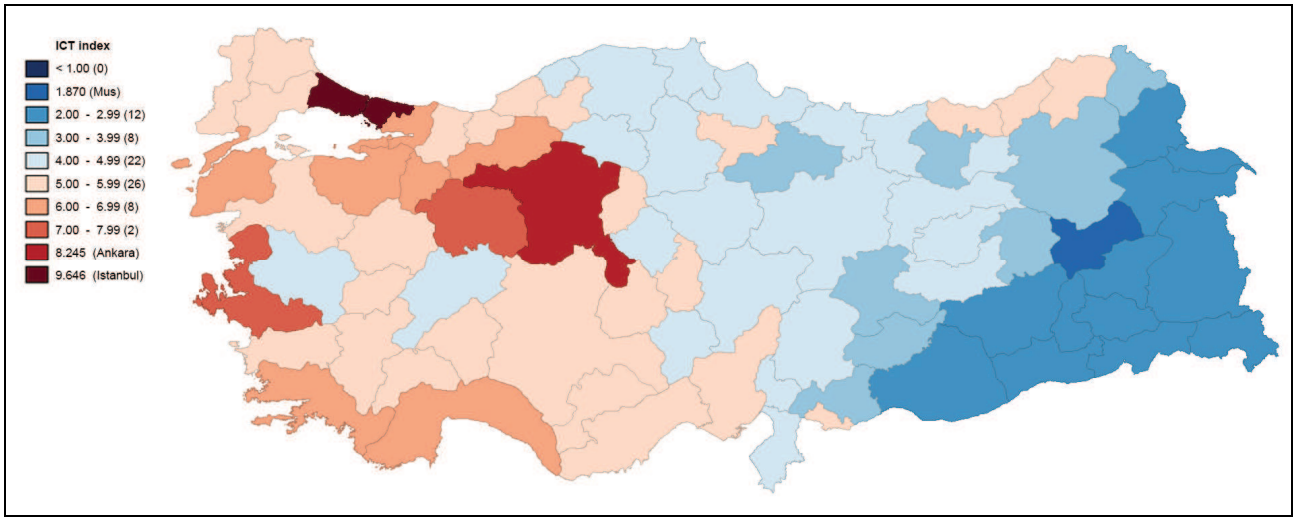

Fig. 2. Digital Divide in Turkey, measured with ICT development index

4.2 Spatial Auto-correlation of the ICT Development Index in Turkey

Spatial auto-correlation of the ICT development index is computed by the use of Getis-Ord Gi* local statistics in 81 provinces in Turkey. With this method, the expected results would propound the dominance of Istanbul, and its neighbouring provinces and weak clusters in the further regions and provinces in Turkey. This paper aims to identify regions or spatial clusters that have similar spatial divergence and to define the level of variances among these clusters. Therefore, it is appropriate to use Getis and Ord Gi* local statistics which is one of the spatial statistical methods to examine the geographic significance in natural and social sciences.

With Getis and Ord Gi* local statistics, the spatial pattern of the digital divide can be analysed and statistically validated. ArcGIS program - Spatial Analyst module with the Hot Spot Analysis application can compute Getis and Ord Gi* Statistics, depicting the spatial distribution of high and low value properties depending on the location of clustering levels. In ArcGIS program, Getis and Ord Gi* Statistics produce spatial functions by Euclidean distance (linear distance) parameter. However, Getis and Ord Gi* statistics in this paper, is derived from the actual path distances among provinces. In particular, it is argued that the actual path distance will constitute a more valid analysis baseline when topography changes and location of provincial centres are examined than the Euclidean distances.

According to the Gi* distribution of ICT development index, Istanbul has still the highest value with a score of 56.563, followed by Ankara with a index score of 40.688. Then, İzmir, Eskişehir, Yalova, Muğla and Antalya exist with the scores above “20”. Due to the higher ICT development index scores in the vicinity of

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İzmir, Izmir rises to 3rd and Eskişehir ranks 4th although they have reverse ranks in the ICT development index without spatial function. In the fourth interval, ; Çanakkale, Kocaeli, Bursa, Amasya, Bolu, Edirne, Bilecik, Tekirdağ, Kırklareli, Balıkesir, Sakarya, Artvin, Karaman, Trabzon, Düzce and Rize exist with a score between 10.00 – 19.99.

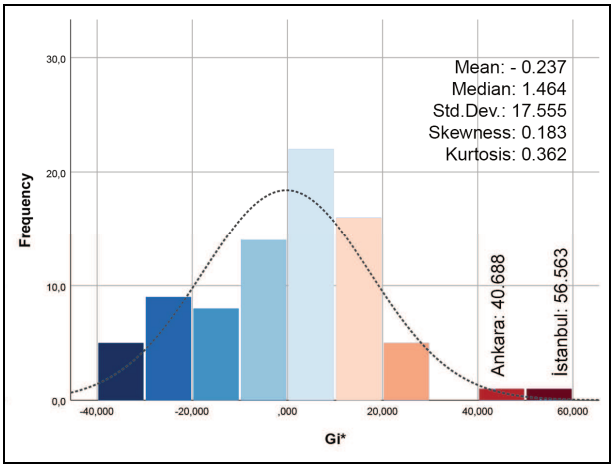

Fig. 3. Getis and Ord Gi* Statistics for ICT development index

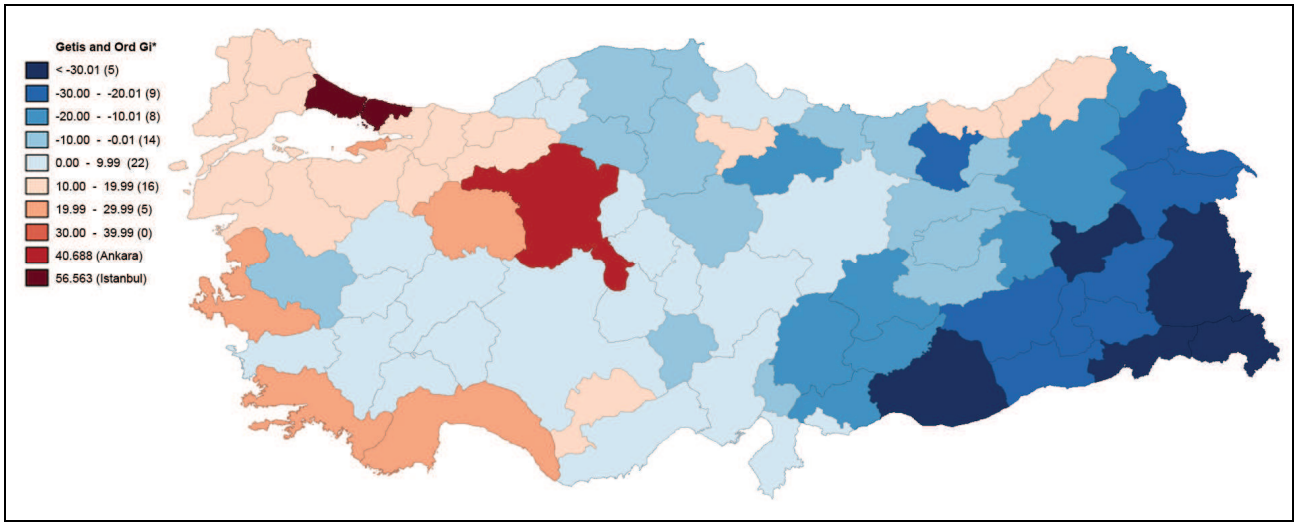

Fig. 4. Spatial Autocorrelation of Digital Divide in Turkey, measured with Getis and Ord Gi* Statistics for ICT development index

5 CONCLUSION

Preliminary findings indicate that spatial auto-correlation and clustering methods report the significance of the mono-centric development pattern of Turkey, where most populated and in-migrated provinces also dominate in all domains of access to, use and skills of technology. Although figures from officially published data depict spatial heterogeneity superficially the results indicate the importance and necessity of a prospective comprehensive social survey, having high level of representation capability and spatial sampling. This paper is assumed to present primer investigations of further research, which will compare Istanbul province, as the dominant province with unprivileged provinces in terms of socio-economic development and technology use and supply.

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