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Smart City Prediction For The City of Izmir Using Fuzzy Logic

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Abstract – There is a global high demand for creating smart cities due to the increasing population of the world and lack of natural resources. There are six stated criteria in order to be eligible to become a smart city, which are directly related to governance, economy, mobility, community, environment and quality of life. In this study, feasibility of a city in order to become a smart city will try to be predicted by using fuzzy logic in the context of afore mentioned parameters.

Keywords – smart city, smart city criteria, fuzzy logic, izmir, big data

I. Introduction

In most cases, development of a city is shown by its growing population and demand of new lands but this expanding trend necessitates a need for an effective integration of all its systems and duties like sewage, water management or waste management. Thus, governments are trying to create cities that are well connected, energy efficient, and sustainable. These cities are called smart cities.

In my study, I will try to forecast if Izmir is a good candidate to be a Smart City in terms of 6 smart city criteria using fuzzy logic through Matlab. In the end, the results of the study is hoped to be helpful to local authorities for determining the level of improvements their city needs for becoming a smart city. The case study of the paper is the city İzmir in Turkey but the proposed fuzzy logic system can be applied to different cities once the variables are set.

II. Literature Review

Narendra Modi, the Prime Minister of India once stated;

"Cities in the past were built on riverbanks, they are now built along highways. But in the future, they will be built based on availability of optical fiber networks and next-generation infrastructure" [1].

As many cities around the world deal with population growth, lack of municipal services for their expanding boundaries, transport issues and connecting with the rest of the world, governments are trying to achieve creating cities that are energy efficient, sustainable and connected with the rest of the world. With this aim local authorities began to try to integrate ICT (information and communication technology) and IoT (internet of things) with their fundamental duties like sewage, energy, water and waste management. According to Allwinkle and Cruickshank, Smart City concept emerged after 2005 and after used mostly for urban development cases. The cities, which uses IT technologies, claim that they are "smart" but these cities have difficulties to identify what they meant by being "smart" [2].

There is no universally accepted definition for Smart Cities. Different countries and associations have defined their own context and framework of a Smart City. For example, while Indian authorities focuses mainly to city itself, Viennese authorities focus both the city and the citizens. According to Indian authorities, a Smart City is a city equipped with high tech communication capabilities. A smart city uses digital technology to increase its performance and well being while reducing costs and resource consumption [3].

Accordingly, Vienna includes its citizens to this definition more intensely. According to Viennese authorities the term also identifies the education level of its inhabitants. According to them, Smart City has also smart inhabitants [4]. Smart Cities Council defines it simply as a city, which has embedded digital technologies across all city functions [5].

Since the concept gain importance, European Parliament also stated following statements about Smart Cities; "A Smart City is a place where the traditional networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of its inhabitants and businesses" [6], "effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens" [7].

While different countries and associations have defined the concept in different terms, Centre of Regional Science (SRF) at the Vienna University of Technology states the smart city concept in six main axes, which are smart economy, smart mobility, smart governance, smart environment, smart people and lastly, smart living [8]. Yet again, SRF at the Vienna University of Technology grouped characteristics and factors of a smart city in its Smart Cities final report on 2007 with the collaboration of University of Ljubljana and Delft University of Technology. Figure 1 summarizes these characteristics and factors on a table.

Smart Economy is a broad definition but it can be simply associated with the economics behind Smart Cities, the different implementations of new technologies to urban commerce and the change of urban commerce within economic environment of Smart City. Smart Mobility term is also a broad definition. It is about the implementation of new

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technologies to the urban mobility. It consists of both actual mobility that is concerning public transport, satisfaction with access and quality of public transport, use of economical vehicles, and the virtual mobility that is concerning the internet access and the respective devices. Smart Governance concerns about the participation of citizens in decision-making process as well as transparent governance. These can be achieved easily by IT implementations. Also public and social services within the city is another important element for the smart governance.

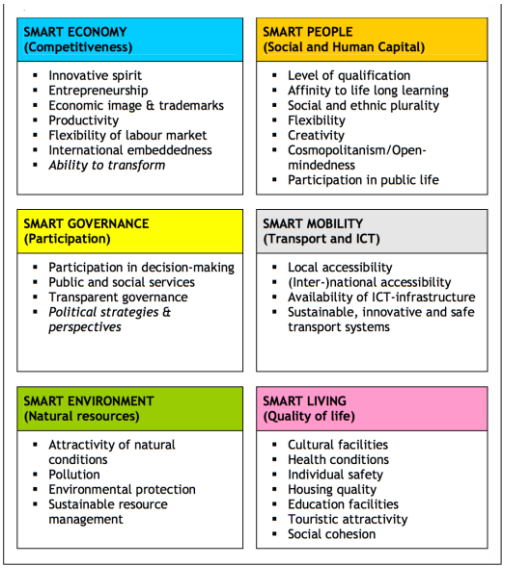

Fig. 1 Criteria for Smart City [4]

A Smart environment is a place where of smart devices and systems are continuously working to make citizens' lives more comfortable [9]. This smart devices or systems can include efficient use of electricity and water, sunshine hours and the green space share of the city and the environmental pollution management systems. Smart People term is mostly about the inhabitants' level of qualification and philosophy of life. It includes the education level, affinity to life long learning, participation in elections and voluntary work. Smart Living can be associated with the environment around the inhabitants or in other words an environment, which can provide comfort, sustainability of resources, quality of education, satisfaction with personal safety and high quality of life.

Since IT implementations have vital importance for Smart City applications, there are many academic studies based on fuzzy logic predictions. These predictions can be used in variety of fields from disaster management systems to traffic management systems or even voting systems. For example, a new method for urban flood monitoring which uses urban open data and remote sensors were proposed by Melo,Silva and Macedo [10]. Another study reveals that fuzzy logic can be used for forecasting parking spots in the city center and this reduces both CO2 emissions and wasted hours that are spent looking for a feasible spot [11]. Likewise another prediction was proposed to establish an intelligent traffic management system for smart cities. The authors concluded from the obtained results that intelligent traffic systems are much more efficient than manual traffic lights and they balance the flow of traffic and they can also reduce or even completely remove unnecessary delays [12].

III. Research Methodology

A. Fuzzy Logic

Classical logic only works with certain data and very strict certain results. However, Fuzzy Logic is a system which allows to use vague data to reach true results as much as possible in instances where vague variables play a role in a decision making process [13]. Fuzzy Logic is an easy to use system for using the variables as input data and map out output data.

While mathematical systems generally use numeric values, fuzzy logic applications can also use non-numeric values. However, for a computer system to analyze such non-numeric data, they should be converted to numeric values [14]. To be more precise, fuzzy logic has three steps, which are fuzzification, rule establishment and defuzzification. In the fuzzification stage, the non-numeric input values are expressed in numeric values, in other words fuzzified, and then, fuzzification operations will use these numeric inputs in fuzzy membership functions. In order to analyze the fuzzified input data, rules have to be established using "if-then" cause. Each rule defines a result for every case and this step is called rule establishment. In the last step, defuzzification operations will give output values that can be used in decision-making processes. In this stage, numeric output values are converted to meaningful non-numeric values for interpretation [15].

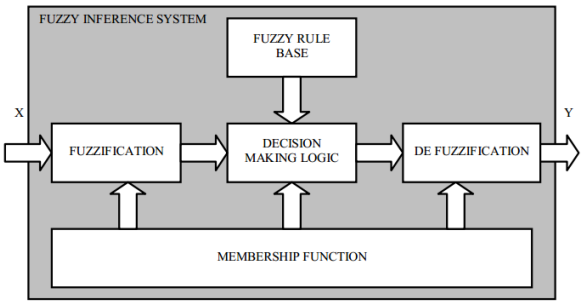

Fig. 2 Fuzzy Logic [45]

B. Proposed System

As stated in the previous section, there are 6 criteria that are taken into consideration for a city to be a smart city. Those criteria are; smart economy, smart people, smart governance, smart mobility, smart environment and smart living. In this study, these 6 criteria are used as the input values for fuzzy membership functions.

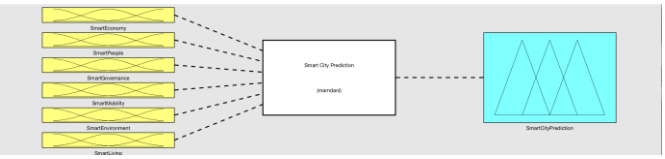

Fig. 3 Input Variables

In order to use these non-numeric values, first of all they were converted into numeric values. Each criterion was appointed one of the three ranges between 0-100. These ranges are "Bad (0 - 49)", "Average (50-79)" and " Good (80-100)". A previous study about the topic was used to assign these numeric values as can be observed in Table 1.

Table 1. Input Membership Function Values, [16].

Variable	Classification	Range
Government	BAD	< 50
	AVERAGE	50 < x < 79
	GOOD	> 79
Economy	BAD	< 50
	AVERAGE	50 < x < 79
	GOOD	> 79
Mobility	BAD	< 50
	AVERAGE	50 < x < 79
	GOOD	> 79
People	BAD	< 50
	AVERAGE	50 < x < 79
	GOOD	> 79
Living	BAD	< 50
	AVERAGE	50 < x < 79
	GOOD	> 79
Life	BAD	< 50
	AVERAGE	50 < x < 79
	GOOD	> 79

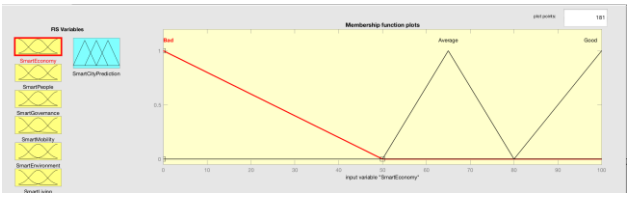

Fig. 4 Membership Functions for Smart Economy

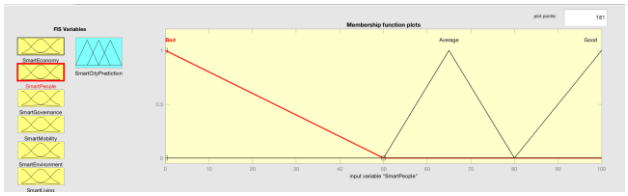

Fig. 5 Membership Functions for Smart People

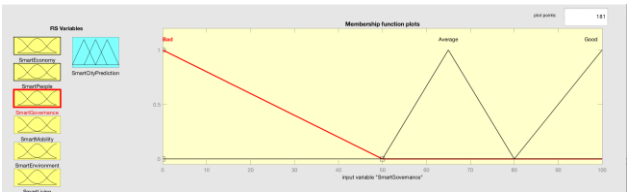

Fig. 6 Membership Functions for Smart Governance

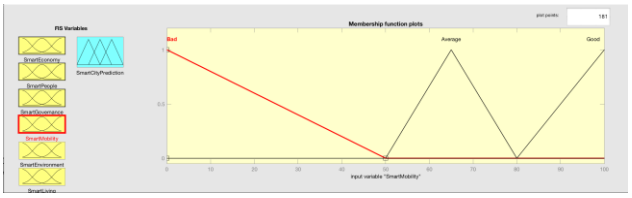

Fig. 7 Membership Functions for Smart Mobility

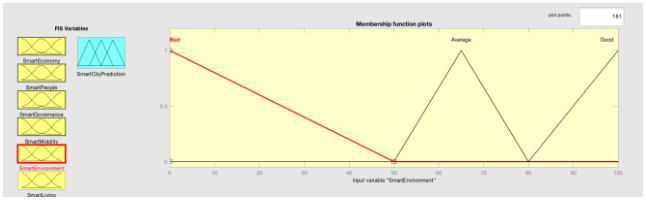

Fig. 8 Membership Functions for Smart Environment

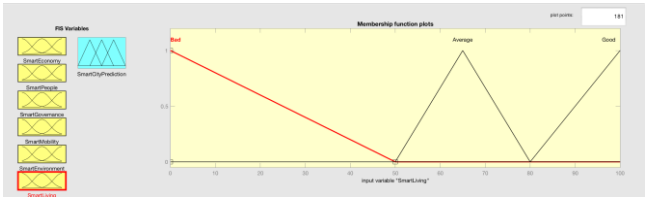

Fig. 9 Membership Functions for Smart Living

In order to measure a city's appropriateness in terms of each criterion more precisely, a number of sub-criteria were used from Center of Regional Science at The Vienna University of Technology's previous studies for the case study İzmir.

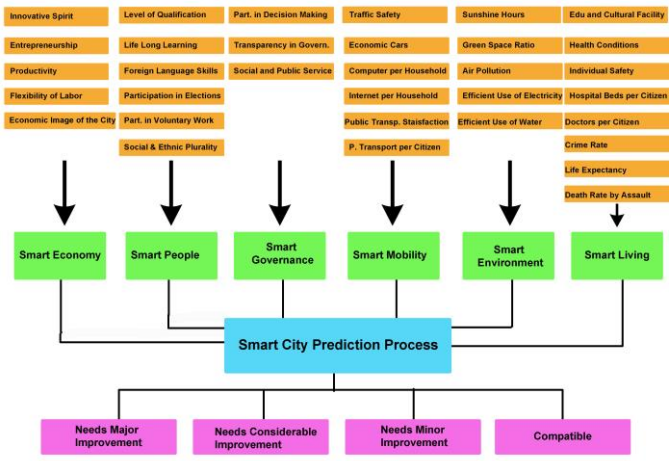

Fig. 10 Criteria and Sub-criteria of Smart City

This study intends to measure a city's appropriateness for becoming a smart city. Therefore, four output values were assigned according to the level of the city. These output values are: "Compatible", "Needs Minor Improvement", "Needs Considerable Improvement" and "Needs Major Improvement". The range for output values are between 0 - 100 like the input values.

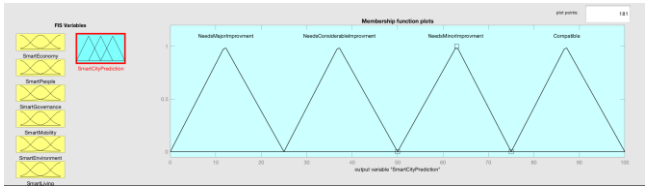

Fig. 11 Outputs

In the next stage, rules were established according to these variables using "If-Then" expressions with the operator "and". There are 729 possible rules for 6 criteria with 3 membership functions resulting from 3*3*3*3*3*3 = 729.

After establishing the rules, the results were obtained in Fuzzy Logic Toolbox in Matlab according to Mamdani

Inference System using the established rules within weighted average method. The purpose of the system is to predict how much improvement a city needs in order to be eligible to become a smart city. In this study, city of İzmir in Turkey has been chosen as the case study.

IV. Case Study: The City of Izmir

All of the variables in Figure 1 were evaluated separately to be able to appoint a range between 0 and 100, which will be used to form the necessary rules for fuzzification process.

The first variable is the "Smart Economy". The most important indicators of "Smart Economy" can be assumed as the innovative spirit, entrepreneurship, productivity, flexibility of labour market and economic image of that city. In this context, Izmir hosts four different technology development zones within the city [17]. As seen on Figure 13, there is a wide and organized entrepreneurship environment in the city. Both governmental agencies and business chambers are creating and supporting entrepreneurship projects [18].

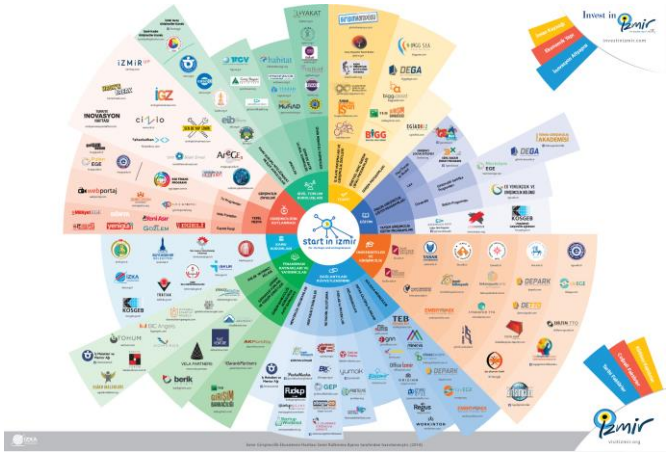

Fig. 12 Izmir Entrepreneurship Ecosystem [18]

Besides that there are some nationwide entrepreneur support programs that are funded by government. While the percentage of demand raises 25% nationwide, the same demand raised 47% in İzmir [19]. Economic image of the city is high due to the high ratings of İzmir recently addressed by the world's most important credit rating agencies, Fitch and Moody's [20]. Besides that, İzmir has many economic trademarks like Yaşar Holding, İnci Holding and CMS Group. İzmir creates 6,60% of total gross value added and it is the 3rd in 81 cities after İstanbul and Ankara according to 2017 - November TÜİK (Turkish Statistical Institute) report [21].

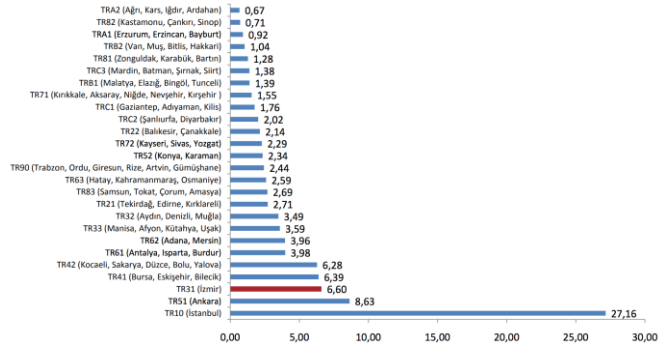

Fig. 13 Gross Value Added Share per Region 2011 (%), [21].

According to a study of Izmir Chamber of Commerce, the job switching rates of the city of İzmir was 26,60% in 2010. Along with many other findings, this percentage can be considered that there is flexibility of labour market in Izmir but still for the lack of recent sources, flexibility of labour market in Izmir should be considered as average [22]. According to these information the appointed range for "Smart Economy" variable is "Good" and the assigned numeric value is 90.

The second variable is the "Smart People". The most important indicators of "Smart People" can be assumed as the level of qualification, tendency to life long learning, foreign language skills, participation to the elections, open-mindedness and participation in voluntary work. In this context; Izmir has the second most literacy rate with 98,19% amongst the other cities in Turkey [23] and 18% of this share is holding a university degree [24]. There are 9 universities in the city but 3 of them are not operational due to the recent coup d'état attempt [25]. Amongst them, only Izmir University of Economics could take a place in Times Higher Education World University Rankings [26]. Additionally İzmir has a very low degree with 48,12 in EF English Proficiency Index [27]. It is thought that the situation is about the same for any other global languages. In this case level of qualification should be considered as low. There is a certain affinity to life long learning from the universities. The local universities like DEU (Dokuz Eylul University) and EU (Ege University) provides certain courses for lifelong learning but still the participation is not at the desired level, especially women's participation is under a certain level due to some social barriers [28]. As already known, Turkey has many minorities due to the cosmopolitan nature of its predecessor Ottoman Empire. Likewise İzmir, which is one of the most important trade and industrial port of Ottoman Empire, has a cosmopolitan nature, too. The most crowded population belongs to Turkish descendant citizens, then Kurdish descendant citizens. Other minorities like Jews, Armenians and Greeks are holding a very little percentage. Likewise, the share of foreigners and the expat community in Izmir also has an insignificant share. Hence, the social and ethnic plurality should be considered as average. The participation to the elections in Izmir has a very high percentage. For example the participation to Izmir mayoral election in 2014 was 90,2% [29] and the participation to the Turkish local elections in 2015 was 89,4% in total [30]. The exact information about participation in voluntary work is not reachable but still when it is considered that it is a very new concept for Turkish citizens the participation to voluntary work is limited with university students. According to these information participation in public life should be considered as average. The overall appointed range for "Smart People" variable is "Average" and the assigned numeric value is 75.

The third variable is the "Smart Governance" term, which includes participation of the citizens in decision-making process, social and public services and transparency in governance. İzmir has 26 representatives in the parliament which means per representative is responsible for 160,000 citizens. Only 3 of these representatives are female [31]. Additionally it is thought that there is no transparent governance within the city due to recent political

environment. The overall appointed range for "Smart Governance" variable is "Bad" and the assigned numeric value is 40.

The fourth variable is the "Smart Mobility" term, which includes a vide variety of sub-terms from traffic safety, public transport, having economical cars and also computers and broadband internet accessibility. Izmir has the 3rd biggest internet subscriber number amongst other cities in Turkey [32]. İzmir has an international airport, which has a direct flight to 70 different locations in 28 different countries [33]. According to this information, international accessibility of İzmir should be considered as high. Traffic safety is another concern and İzmir is in the second place in most deadly traffic accidents and from that information we can assume that traffic safety is low [34]. Local accessibility is another important issue. According to a recent survey, which was conducted by İzmir Metropolitan Municipality, the satisfaction degree of public transport in İzmir is 79%. Additionally the ratio of public transport network per inhabitant is 0,58 [35]. Overall appointed range for "Smart Mobility " variable is "Good" and the assigned numeric value is 80.

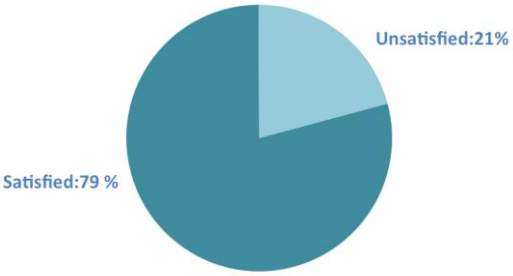

Fig. 14 İzmir Public Transportation System Degree of Satisfaction [35]

	İSTANBUL	ANKARA	İZMİR
Population	14.657.434	5.270.575	3.920.224
Number of Passengers, using Public Transportation	6.174.384	2.479.290	2.289.736
Commuting with Public Transport per person	**0,42**	**0,47**	**0,58**

Fig. 15 City Of İzmir Public Transport Network per Inhabitant [35]

The fifth variable is the "Smart Environment". As the term clearly states it is about environmental indicators like sunshine hours, green space ratio, air pollution and sustainable resource management, which include efficient use of water and electricity.

According to Turkish State Meteorological Service, İzmir has 94,5 sunshine hours annually [36]. Additionally the green space share of the city is just 1,45% [37]. Concordantly İzmir has one of the most polluted air in Turkey [38]. İzmir Metropolitan Municipality admits that they can't use electric sources efficiently and they included this matter to their 2016-2017 strategic plan [39]. On the contrary İzmir Metropolitan Municipality is using water resources efficiently. There are 11 water treatment plants and 61 wastewater treatment facilities within the city perimeters [40]. Since the only good environmental process within the city is water, the range "Bad" is appointed for the "Smart Environment" variable and the assigned numeric value is 30.

The last variable is "Smart Living" and it consists of some indicators like education and cultural facilities, health conditions, individual safety and touristic activities.

According to a report which is published by the İzmir Government Office, there are 19,239 cinema seats and the tickets sold for these seats were around 3,6 million.

On the other hand, there are almost 22 thousand theatre seats but still the tickets sold for these seats were just 340 thousand [24]. In the first 11 months of 2017, around 1,5 million visitors visited the museums of İzmir, which includes domestic and international visitors also. According to Figure 6, the most visited museum is Ephesus, which is mostly visited by foreign visitors. In this case we can assume the visitation numbers of museums by the citizens of İzmir is low [41].

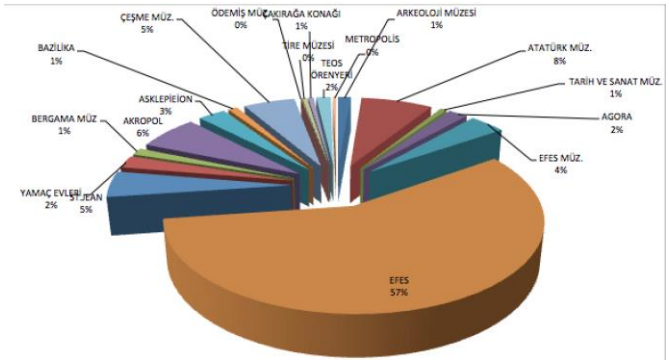

Fig. 16 Museums of Izmir [41]

The life expectancy for Turkey is 78,8 years. In Izmir this number was 75,8 for male citizens and 81,9 for female citizens [42]. The average of this number is almost equal to the national average but still lower than the EU average [43]. The numbers about health can be seen in the Table 2.

Table 2. Some indicators of health in the City of Izmir, [24]

2015	Turkey	İzmir
Bed numbers per 100.000 inhabitant	266	275
Total doctors	141.259	9996
Patients per doctor	557	417

Individual safety is a very important indicator of "Smart Living". İzmir is the third homicidal city after Istanbul and Adana and the forth city in terms of serious crimes [44]. In this case individual safety can be assumed as low within the city. And lastly, Izmir is one of the main touristic attractions of Turkey. While Çeşme district is favorite of mostly domestic tourists, ancient Ephesus City is favorite of both domestic and international tourists. According to all these information, the overall appointed range for "Smart Living " variable is "Average" and the assigned numeric value is 65.

After the input values for İzmir case has been entered into the toolbox, the outcome was 50, which means İzmir is at the intersection point of "Needs Considerable Improvement" and "Needs Minor Improvement" output values. This means

İzmir needs to make some improvements considering the Smart City criteria.

Table 3. Assigned Numeric Values To The Inputs

List of Variables	**Range**	**Assigned Values**
Smart Economy	Good (> 79)	90
Smart People	Average (50 < x < 79)	75
Smart Governance	Bad (<50)	40
Smart Mobility	Good (> 79)	80
Smart Environment	Bad (<50)	30
Smart Living	Average (50 < x < 79)	65

V. CONCLUSION

Smart City concept consists of different integrated structures and several parameters. Additionally there are some certain requirements to meet that is necessary to be officially announced as a Smart City. To be able to manage this process in an orderly manner, an objective assessment is required. At this point, fuzzy logic methods can provide a highly constructive contribution in determining whether a city is suitable to getting the Smart City tag or not. Fuzzy logic implementations can help the officials to determine the weak and the strong sides of the city. Thus, a pathway can be drawn with the outcomes of such applications for the cities, which do not meet these certain criteria to follow.

REFERENCES

[1] Parr, B., & Henry, D. (2015). India's rapid transition: The Modi government's climate change and development plan. unimelb.edu.au. Retrieved 24 December 2017, from https://sustainable.unimelb.edu.au/sites/default/files/docs/MSSI-Briefing-Paper3_India2015.pdf

[2] Allwinkle, S., & Cruickshank, P. (2011). Creating Smart-er Cities: An Overview. Journal Of Urban Technology, 18(2), 1-16. http://dx.doi.org/10.1080/10630732.2011.601103

[3] Smart City. www.mygov.in. Retrieved 24 December 2017, from https://www.mygov.in/sites/default/files/mygov_14461820141708050 1.pdf

[4] Centre of Regional Science. (2017) (p. 12). Retrieved from http://www.smart-cities.eu/download/smart_cities_final_report.pdf

[5] Smart Cities Council Definitions and overviews. Smartcitiescouncil.com. Retrieved 24 December 2017, from http://smartcitiescouncil.com/smart-cities-information-center/definitions-and-overviews

[6] European Parliament: Mapping Smart Cities in the EU. Policy Dept. A: Economic and Scientific Policy. IP/A/ITRE/ST/2013-02, 2014

[7] Mapping smart cities in the EU, Directorate-General for Internal Policy, IP/A/ITRE/ST/201. Retrieved from http://www.europarl.europa.eu/RegData/etudes/etudes/join/2014/507480/IPOL-ITRE_ET(2014)507480_EN.pdf.

[8] EC, European Commission, Digital Agenda for Europe (DAE), 2014, Retrieved 24 December 2017, from https://ec.europa.eu/digital-agenda/en/about-smart-cities

[9] Cook, Diane; Das, Sajal (2005). Smart Environments: Technology, Protocols and Applications. Wiley-Interscience.

[10] Melo, F. S., Silva, J. L. M., & Macedo, H. T. (2016, April). Flood monitoring in smart cities based on fuzzy logic about urban open data. In Telematics and Information Systems (EATIS), 2016 8th Euro American Conference on (pp. 1-5). IEEE.

[11] Trista Shuenying Lin. Smart parking : Network, infrastructure and urban service networking and Internet Architecture [cs.NI]. INSA de Lyon, 2015. English. 〈NNT : 2015ISAL0138〉

[12] Sandhu, S. S., Jain, N., Gaurav, A., & Iyengar, N. C. S. N. (2015). Agent Based Intelligent Traffic Management System for Smart Cities. International Journal of Smart Home, 9(12), 307-316.

[13] Gültekin, B., Biroğlu, S., & Yücedağ, İ. (2015). İşe Alım Süreci Aday Ön Tesbitinde Bulanık Mantık Tabanlı SQL Sorgulama Yönteminin İncelenmesi. Düzce Üniversitesi Bilim ve Teknoloji Dergisi, 3(1).

[14] Mert, Z. G., & Yilmaz, S. (2009). Fuzzy modeling approach based on property location quality for grading neighborhood level of family housing units. Expert Systems with Applications, 36(2), 3603-3613. DOI: 10.1016/j.eswa.2008.02.023

[15] Güner, N., & Çomak, E. (2014). Lise Öğrencilerinin Matematik Dersine Yönelik Tutumlarının Bulanık Mantık Yöntemi İle İncelenmesi. Pamukkale University Journal of Engineering Sciences, 20(5).

[16] M. Iswan, Khairul and A. P. U. Siahaan, "Fuzzy Logic Concept in Technology, Society, and Economy Areas in Predicting Smart City," International Journal of Recent Trends in Engineering & Research, vol. 2, no. 12, 2016.

[17] TDZ's in Izmir | Invest in İzmir. Investinizmir.com. Retrieved 24 December 2017, from http://www.investinizmir.com/en/28309/TDZs-in-Izmir

[18] İzmir Girişimcilik Ekosistemi. Izka.org.tr. Retrieved 16 December 2017, from http://www.izka.org.tr/upload/Node/30334/pics/Izmirde_Girisimcilik_2_.820px.jpg

[19] Girişimci sayısında İzmir fark attı. (2017). yeniasir.com.tr. Retrieved 22 December 2017, from https://www.yeniasir.com.tr/ekonomi/2017/01/24/girisimci-sayisinda-izmir-fark-atti

[20] Fitch'ten İzmir'e bir kez daha AAA notu. (2017). tr.sputniknews.com. Retrieved 25 December 2017, from https://tr.sputniknews.com/ekonomi/201711201031070383-fitch-izmir-aaa-notu/

[21] Sayılarla Türkiye - İzmir Kasım 2017. (2017). Izka.org.tr. Retrieved 25 December 2017, from http://www.izka.org.tr/upload/Node/30496/files/Sayilarla_Tu_rkiye-I_zmir_Kasim_2017.pdf

[22] İzmir İşgücü Piyasası Araştırması. (2010). Kutuphane.ieu.edu.tr. Retrieved 25 December 2017, from http://kutuphane.ieu.edu.tr/wp-content/46IzmirIsgucu.pdf

[23] İzmir'de okur yazarlık oranı yüzde 98.19. (2016). Hürriyet. Retrieved 23 December 2017, from http://www.hurriyet.com.tr/izmirde-okur-yazarlik-orani-yuzde-98-19-37273861

[24] İstatistiklerle İzmir. (2017). Izmir.gov.tr. Retrieved 18 December 2017, from http://www.izmir.gov.tr/istatistiklerle-izmir

[25] İzmir Bakırçay Üniversitesi. (2017). www.haberturk.com. Retrieved 25 December 2017, from http://www.haberturk.com/yazarlar/huseyin-aslan/1500030-izmir-bakircay-universitesi

[26] 2016-2017 En iyi üniversiteler sıralaması açıklandı!. (2016). CNN Türk. Retrieved 20 December 2017, from https://www.cnnturk.com/universiterehberim/2016-2017-en-iyi-universiteler-siralamasi-aciklandi-iste-siralamaya-giren-turk-universiteler?page=11

[27] EF EPI 2017 – Turkey. (2017). Ef.com.tr. Retrieved 16 December 2017, from https://www.ef.com.tr/epi/regions/europe/turkey/

[28] Öngör, S. (2014). Lifelong Learning Strategies in Turkey/Izmir The Purpose of Learning and Barriers to Women's Participation (Master's). Stockholm University.

[29] Seçim 2014 Ege Bölgesi İzmir Yerel Seçim Sonuçları. (2014). Haberturk.com. Retrieved 16 December 2017, from http://www.haberturk.com/secim/secim2014/yerel-secim/sehir/izmir-35

[30] İzmir'de Kasım 2015 Türkiye genel seçimleri. (2017). Tr.wikipedia.org. Retrieved 10 December 2017, from https://tr.wikipedia.org/wiki/%C4%B0zmir%27de_Kas%C4%B1m_2015_T%C3%BCrkiye_genel_se%C3%A7imleri

[31] Türkiye Büyük Millet Meclisi. Tbmm.gov.tr. Retrieved 16 December 2017, from https://www.tbmm.gov.tr/develop/owa/milletvekillerimiz_sd.liste

[32] Akgüngör, S., Kumral, N., & Çelik, N. (2017). Ekonomik ve Demografik Göstergelerle İzmir (p. 15). Izmir: EGIAD.

[33] Akgüngör, S., Kumral, N., & Çelik, N. (2017). Ekonomik ve Demografik Göstergelerle İzmir (p. 23). Izmir: EGIAD.

[34] İllere göre trafik kazası istatistikleri - 2016. (2017). memleket.com.tr. Retrieved 19 December 2017, from http://www.memleket.com.tr/illere-gore-trafik-kazasi-istatistikleri-2016-1048380h.htm

[35] 120 bin kişilik anket: İzmir'in ulaşım röntgeni. (2017). Egedesonsoz.com. Retrieved 20 December 2017, from http://www.egedesonsoz.com/haber/120-bin-kisilik-anket-izmir-in-ulasim-rontgeni/942654

[36] Resmi İstatistikler. (2017). Mgm.gov.tr. Retrieved 9 December 2017, from https://www.mgm.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx?m=IZMIR

[37] Coşkun Hepcan, Ç., Özeren, M., & Hepcan, Ş. (2013). İzmir için ekolojik açıdan sürdürülebilir bir kent gelişim senaryosu, TMMOB İzmir 2. Kent Sempozyumu Bildiriler Kitabı, TMMOB İzmir, 2, 28-30.

[38] Bozoğlu, B. (2017). Hava Kirliliği Raporu 2016 (p. 15). TMMOB Çevre Mühendisleri Odası. Retrieved from http://www.cmo.org.tr/resimler/ekler/a941df595b4c831_ek.pdf?tipi=67&turu=H...0

[39] Boztepe, M. (2009). Ġzmir ve Çevresinde Yenilenebilir Enerji Kaynak-ları Potansiyeli ve Kullanımı. İzmir Kent Sorunları Sempozyumu.

[40] Tesislerimiz. Izsu.gov.tr. Retrieved 25 December 2017, from http://www.izsu.gov.tr/pages/Tesisler.aspx?b=7

[41] *2017 Yılı Müze İstatistikleri*. (2017). *Izmirkulturturizm.gov.tr*. Retrieved 19 December 2017, from http://www.izmirkulturturizm.gov.tr/TR,173406/2017-yili-muze-istatistikleri.html

[42] İllere ve cinsiyete göre doğuşta beklenen yaşam süreleri, 2013-2014. (2015). Tuik.gov.tr. Retrieved 19 December 2017, from http://www.tuik.gov.tr/PreIstatistikTablo.do?istab_id=2294

[43] AB üyesi ülkelerde doğuşta beklenen yaşam süresi ülkemizden 2,9 yıl daha fazla. (2016). Tuik.gov.tr. Retrieved 21 December 2017, from http://www.tuik.gov.tr/basinOdasi/haberler/2016_108_20161018.pdf

[44] Türkiye'nin 2016 şiddet (cinayet) haritası. (2017). blog.umut.org.tr. Retrieved 18 December 2017, from http://blog.umut.org.tr/turkiyenin-2016-siddet-cinayet-haritasi.html

[45] Karabegovic, Almir & Avdagic, Zikrija & Ponjavic, Mirza. (2006). Applications of Fuzzy Logic in Geographic Information Systems for Multiple Criteria Decision Making.