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Smart Cities Transformation in Turkey

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Abstract

The main purpose of this study is to define measures that need to be taken in order to transform cities in Turkey into smart cities. Integrated operation principles and the policies needed for putting relevant governance models into practice will also be determined. It is important to raise the awareness of the every individual against climate change and they must work to reduce greenhouse gas footprint. Beside all, urban activities are important factors for the increase of greenhouse gas emissions. Potential of CO_2 and CH_4 emissions caused by agricultural and livestock activities have been identified for this paper. As a result, an information society is generated by implementing smart applications. Smart applications within metropolitan areas and urbanization have to be prioritized and the planning for these implementations must be developed. Intelligent transport systems should be developed and the interoperability among the applications of different institutions must be provided. Smart applications in the fields of health, urban transport, housing, energy, disaster and water management has to be supported in accordance with the priorities determined by the regional development agencies. Production and commerce of high technology products needs an implementation of the necessary environment that involves citizens in innovation.

Keywords:	Climate change; Information society; Smart cities; Turkey; Urbanization
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1. Introduction

Smart Cities approach in urbanization would improve living standards of citizens through improving efficiency of urban systems, living environment, quality of services provided to citizens and competitiveness of cities, respectively. Smart cities solutions have a big potential in order to cope with societal challenges in cities. Many cities have already introduced smart applications in Turkey, particularly in transport and urban services. But smart applications in the fields of energy and water management are in their infancy. The biggest challenge hampering widespread implementation of smart cities solutions within urban areas is the lack of financial fund, expert engineers, and skilled labour. Also, the missing geographical information systems (GIS) infrastructure is another challenge against the smart cities transformation. Turkey's current potential can lead to the formation of smart cities transformation and a high degree of information society. Results of this research show that lower carbon dioxide emission initiatives are embodied within the environmental sustainability agenda are not clearly defined yet in the smart cities concept.

Urban growth management and sustainable urbanisation process have taken place as the most important agenda of the 21st century. The concept of smart cities has evidently taken steps towards smartness and technologically based solutions of complex city challenges have adopted initiatives for transforming cities to energy-efficient settlements. Scholars argue that the smart city could provide a transformative panacea for urban development, as well as inform planning and policy decisions of the cities [1 - 4]. Smart services transform the city and its inhabitants technologically, governmentally, economically and socially. Along with these smarter solutions, dissemination of the sustainability ideology has had a significant imprint on the planning and development of our cities [5, 6].

The term smart generated from Smart Growth movement and has become a common term which supports new policies for urban planning over the past decade [2]. Hodgkinson [3] then proceeds to adduce the term smart has become part of the language of urbanization policy, referring to the clever use of IT to improve the productivity of a city's essential infrastructure and services and to reduce energy inputs and CO_2 outputs in response to global climate change. Mitchell [1] state that the increasingly effective combination of digital telecommunication networks (the nerves), ubiquitously embedded intelligence (the brains), sensors and tags (the sensory organs), and software (the knowledge and cognitive competence) create smart environments. Nevertheless, services and infrastructures that are supported by using information and communication technologies (ICT) are defined as Smart City.

Smart City infrastructure used by citizens has similarities with intelligent applications they use today. Wireless internet, eBooks, smartphones, sensor networks, Facebook and Google map, android applications are examples of intelligent applications. Construction of the digital city must have four critical elements that are economic, social and environmental sustainability and the inspiring leadership.

Smart city restructuring is innovative and focused on citizen satisfaction. It comprises concept of continuous access of the citizens and working of the entire unit with a single automation system. Each process is performed at a time. It is a systematic solution, repeatable, expandable with new modules. It is sustainable, the process involves the improvement, and it gets into the positive economic effects of the elements.

The majority of citizens living in the city should have adapted to the city and fulfil the duties and responsibilities the urban life [7]. This is a key indicator for the formation of a smart city. There are many benefits that are provided to urban management and citizens by building the Smart Cities.

National Academy of Sciences report [8] declared that complex city systems and human interventions are the ones risking climate change, whereas understanding issues connected with cities and complexities can help measure and decrease the impacts of carbon dioxide (CO_2) emissions and climate change. In this respect, individual choices would either reflect a response to city challenges, such as carbon dioxide reduction, or be stringently set within the context of a lens that considers most deeply their views [9]. Cavada et al. [9] support the idea that evaluating the carbon dioxide significance of smartness is undoubtedly going to be problematic, not least when engineers have yet to evaluate fully the complexities of the smart agenda itself. Moreover, one of the associated challenges appears to be a lack of official smartness indicators at international or national levels, and where they do exist 'low carbon dioxide' appears to be somewhat lost within the smart cities agenda [9].

This research is mainly addressing the agenda of low CO_2 emissions that provide a range of sources for smart city rankings. Smart city concept and its potentials for solving complex urban challenges is explained in a comprehensive manner and reveal a general analysis of world examples within the framework of the principles and criteria for attaining smartness in cities. The inferences from this analysis can provide a basis for the Turkish smart solution initiatives.

2. Smart city concept

Transportation systems, electric, water and sewage infrastructures, security, health and public safety are integrated into the urban infrastructures and services through the smart city concept. ICT based initiatives by some technology companies like IBM, Siemens and Cisco had a trigger effect on the advancements in planning, development, operation and sustainability of urban services and facilities at the beginning of 2000s [2]. Smart city concept can supports sustainable development and brings solutions for diverse problems of development. The term Smart City cannot be used for describing a city as a whole. However, it can be used to discuss its different components like its citizens, governance, communication, economy, environments or transportation. Most of the activities in urban growth can be related with the Smart City e.g. education, urban infrastructure, user participation, industry [10]. Smart City includes strong relation between the city administration and its citizens. Recent solutions in urban activities like transport technologies, public safety, environmental sustainability and energy can be associated with Smart City [10, 11].

Smart cities Ranking of European medium-sized cities is the research was carried out in collaborative work of the Centre of Regional Science at the Vienna University of Technology (lead partner), the Department of Geography at University of Ljubljana and the OTB Research Institute for Housing, Urban and Mobility Studies at the Delft University of Technology. Research report was edited by the Centre of Regional Science (SRF), Vienna University of Technology in October 2007. Research project focused on the 70 medium-sized cities and thereby considering a broad range of factors and indicators, inherent to the concept of smart cities [10]. Giffinger et al. [10] identified six characteristics (see Table 1) as a roof for the further elaboration of smart cities which should incorporate the findings but also allow an inclusion of additional factors.

Table 1: Characteristics and factors of a smart city (adopted from Giffinger et al. [10])

Characteristics	Factors
SMART ECONOMY (Competitiveness)	Refers to competition, simplified and supported entrepreneurship, productivity, creativity, innovation and labour market flexibility and connection to local and international markets.
SMART PEOPLE (Social and Human Capital)	It is related to qualification and education level of the citizens. It also related to the quality of social interaction of people and integration with entire community with enriched public relations and global interconnectivity.
SMART GOVERNANCE (Participation)	Refers to public and social services, political strategies and perspectives, participation in decision-making that facilitate participation process for citizens
SMART MOBILITY (Transport and ICT)	Includes local and international accessibility, availability of ICT infrastructure, sustainable, innovative and safe transport systems
SMART ENVIRONMENT (Natural resources)	Refers to attractivity of natural conditions, pollution, environmental protection, sustainable resource management
SMART LIVING (Quality of life)	Covers several aspects of quality of life such as cultural facilities, health conditions, individual safety, housing quality, education facilities and social cohesion

Most of the scholars [12 - 16].have introduced the terms and definitions related to building the cities of the future and the future of the cities by using the state of the art information and communication technologies (ICT): smart, intelligent, ubiquitous, digital, knowledge, sustainable, green, creative and innovative [4]. Nam and Pardo [13] suggested four dimensions for the concept of smart cities; (i) Infrastructure and ICT: Adoption of strategies for modern infrastructure, (ii) Creative economy and knowledge-based society: Improving competitiveness and favourable environments, (iii) Sustainability: Promoting green economy and high social awareness in an environmentally sustainable lifestyle, (iv) Human infrastructure: Investment in social and human capital; engaging citizens in governance processes [4].

A Technical Report was written by the focus group on smart and sustainable cities connected to the International Telecommunication Union (ITU) with the aim of establishing a concrete definition for smart sustainable cities which can be used worldwide [17]. Approximately 116 existing definitions of smart sustainable cities were studied and analysed by using as a guideline the attributes and themes of Smart Sustainable City developed in a parallel ITU-T Technical Report on the Overview of Smart Sustainable Cities [17]. According to the report [17] although there is abundant literature available on smart cities, there is no standardized, commonly accepted set of terminologies which would help to aptly describe a Smart City. Furthermore, such a standardized definition will help create a more defined structure in relation to information and communication technology (ICT) infrastructure, key performance indicators, metrics and policies for smart sustainable cities as viewed by ITU. The following common criteria were used as a guideline, based on key attributes: (1) sustainability, (2) quality of life, (3) urban aspects, and (4) intelligence or smartness [17]. Prado et al. [4] proposed a smart city definition within the light of the review of the literature as follows: "Smart city is a community that systematically promotes the overall well-being of all of its residents and which is flexible enough to proactively and sustainably become an increasingly better place to live, work and play.

Prado et al. [4] noticed that two different research agendas were emerged from the proposed definitions of smart cities: (i) How to start and drive the transformation process of places in smart cities, and (ii) How to assess this process. The first agenda includes framework proposals, strategies, approaches, methods and techniques for planning, initiating and managing transformation processes of a given geography in a smart city; The second research agenda includes conducting studies that propose mechanisms to evaluate a locality, not only according to the metrics associated with the various domains of a smart city [18], but also their ability to autonomously conduct the transformation processes it will need to go through to become an even better place to live [4].

3. Methodology

Today, smart city solutions are aimed at improving the quality of life of people living in urban. It is gaining importance in many cities around the world. Laws for the smart city transformation are put into practice quickly to solve the problems.

Smart city solutions for energy, environment, water, transportation, urban services, security and health care can be analysed integrated with Urban Information Systems (UIS) and Geographical Information System (GIS) [19].

However, first of all main problems faced by cities have to be defined.

3.1. Energy area

In energy area, losses in the distribution and illegal use of electricity are increasing. More expensive and inefficient energy sources are used with increasing energy demand.

3.2. Environmental area

In environmental area, renewable resources are being rapidly depleted in cities. The increase in the number of vehicles, environmental problems such as air and water pollution is also a major threat to people living in urban areas. Irregular and unplanned urbanization, infrastructure and the collection of solid waste and storage brings environmental problems [20].

"Ecology" as the first word was used by Ernest Haeckel, a German biologist, in 1866 [21]. Ecological degradation through pollution is especially due to the rapid migration from rural to urban areas, population growth, rapidly growing consumption in connection with industrialization, and waste production as a result of diminishing natural resources. This situation will affect the lives of future generations, especially in recent years, many experts from relevant disciplines, politicians and local officials are working to find solutions to the problem. A special kind of ecological policy provides interactions between people and the environment. Sustainable eco-friendly urban planning requires shaping the old and new town centres using ecological approach. Ecological approach takes place by elements such as the geographical location of the city, climatic data, ecological data, development level, the adequacy of local resources, energy sources, infrastructure of the environment, waste recycle capacity. It plays an important role in shaping the city between disciplines, "City Planning", "Architecture", "Landscape Architecture", "Infrastructure Engineering", "Environmental Engineering" and so on.

Environmentally sensitive planning strategies carry the scientifically determined priorities and environmental standards regarding air, water and soil quality, noise etc. In what extent and how the strategy planning, design and implementation stages must be determined. In this context, legal, administrative and financial measures should be considered and established. Improvements in municipal services has emerged the concept of eco-technology foreseeing the harmonious environmental and technological compatibility in the world. Smart City concept, as well as information cities, digital cities, means using smart systems that creates behavioural changes in urban life and society, which led to the development of economy along with the low carbon release. In the wider sense, both ecological and technological city is managed by an intelligent technological architecture, which requires and Information technology (IT) based management to devise smart cities [22].

3.3. Water area

In water area, insufficient supply of urban water resources located near the city is a big problem. Urban pollution threats the quality of fresh water resources and high consumption prevents their ability to regenerate.

3.4. Transportation area

For instance, in transportation area, the existing transport infrastructure is not able to carry the increasing number of vehicles with the population, and the time elapsed in the traffic is increasing. Lost time in traffic causes job losses, fall in productivity, increase in transportation costs and an increase in harmful exhaust emissions. The number of traffic accidents is increased, in addition to the life losses, health care costs are increased.

There are many solutions that are aimed for easing the daily vehicle traffic. Main objective of the solution is the planning of freight movement in the city or regional scale. The production areas should be separated from the life of the city. Also, the freight transport should be configured independent from the passenger transportation. Logistic villages should be constructed to establish a good way of industry and trade relation.

Intelligent Transportation Systems (ITS) are implemented to ensure more efficient and effective use of transport infrastructure integrated with the improved security, electronics, communications and information processing technologies. Road and highway intelligent transportation systems consist of large-scale traffic control and management systems, traffic signalling systems, weather and road conditions and driver

information systems, large-scale communications systems in road and highway infrastructure, road and highway incident management, electronic payment systems, and passenger information systems.

3.5. Urban services

Smart cities need technological development for geographical information systems (GIS) [23], city digital maps, transportation information system, smart signalling system, smart gauges, information kiosks, high speed internet infrastructure, wireless internet infrastructure, 5G GSM technology, intelligent building architecture, renewable energy, citizens' address and population information system, waste management system, vehicle and infrastructure for the rail system.

3.6. Security issue

In security area, population density and income disparities in cities lead to an increase in the crime rate. Timely and appropriate preventive solutions cannot be produced for increased security problems.

3.7. Health care area

In health area, especially because of the problems caused in transport, delays may be experienced in emergency response. Control of epidemics in urban areas is difficult due to the population density. Urban life's environmental impact adversely affects public health.

4. Results

Republic of Turkey Ministry of Development offers Smart City formation under the following headings:

The reliability of the technology, which requires a reliability and health in traditional infrastructure; technology life cycle, in which the evaluation of the speed of technological change and the key competencies are needed to understand; existing platform compatibility, which requires long-term vision of a common information structure and infrastructure; and security, which is required for most of the smart city technologies to collect sensitive data over networks and channels (for example, images from the camera, city dwellers, electricity use and control information). Security issues should be resolved prior to application of the smart solutions certainly by the city and suppliers. Citizens, at home, in transportation centres, shopping malls can easily reach the information by integration of the mobile application options for all applications as a requirement for the Smart City Building [24, 25].

Prado et al. [4] stated that presently, there is no fully-fledge smart cities exist. Over 26 global cities are expected to be smart cities in 2025, with more than 50% of these smart cities from Europe and North America [26]. At the moment with the building of these cities underway in a number of places around the world, smart city examples abound in both the popular media and in academic discussions [4].

In the European Union, and in the world, Smart urban applications are based on eco-technology [7, 19]. Since 1992 European cities launched many projects regarding the establishment of the smart cities. There are many examples for smart city projects in the world (see Table 2).

The smart city concept is really a framework for a specific vision of modern urban development. It recognizes the growing importance of information and communication technologies (ICT) as drivers of economic competitiveness, environmental sustainability, and general livability. The smart cities of the future will foster economic growth, improve the lifestyle of citizens, create opportunities for urban development and renewal, support eco-sustainability initiatives, improve the political and representative process, and provide access to advanced financial services [36].

Some of the most remarkable smart city project examples around the world are listed in Table 2 are non-comprehensive and are likely to expand as more cities look to the application of ICT and new technologies as an integral part of their city functions. While all of them share the common theme of adopting ICT and new technologies, the fields of application range broadly from transportation to environmental monitoring. All of the projects for the smart cities are in different stages of development. Some of the cities (e.g. Singapore, Amsterdam) have already implemented systems that are currently in use, while the others in a conceptual or development phase. Most of the cities are reported to be working with major global technology providers such as IBM, Siemens or Cisco; while the others have named local or regional technology providers and research institutions as partners.

The first application in Turkey was launched for Yalova city in early 2000, which was conceptually eco-tech Informatics (IT) Valley project. Informatics Valley project was later raised for Bursa, Kocaeli, Ankara and other cities. However, apart from this description, smart city applications were put into parctice in some of the districts in Istanbul Municipality. Many municipalities, such as Fatih and Beyoğlu, use google earth program to implement three-dimensional images of the street. By the smart city transformation program, municipalities initiated management data system and geographical data system.

Table 2. Smart city project examples in the world

Location (City and country)	Project framework	Project source	Project development stages
Dublin, Ireland. Sydney, Australia.	Traffic management system (TMS), and Transit oriented development [27, 28]	Dublin City University, Ireland. Planning Research Centre at Sydney University.	Survey to gather requests of consumers. Data sensing and gathering (DSG). Data storage in databases. Queries processing and optimization. Cultural borrowing from Japan regarding the transportation system.
Dallas, Texas, USA. Padova, Italy.	Secure Internet of Things (IoT) architecture for Smart Cities [29, 30]	Southern Methodist University, USA. European Commission.	Secure routing by black networks. Trusted SDN (Software Defined Networking) controllers. Unified registry. External key management. Structural health of buildings. Noise monitoring, traffic congestion, waste management, air quality monitoring, smart parking and lighting.
NY, USA.	Urban Information Model [2]	IBM corporation.	Social systems (people, commerce, culture, policy). Services (energy, water, transport, building services). Resources (water, air, oil, minerals). Infrastructure (land use, roads, buildings, utilities). Natural environment (topography, environment, resources).
Boston, Massachusetts, USA.	City Innovation, ICT Discover BPS School Choice (MONUM DoIT) Community PlanIT (MONUM, BPS) [31]	IBM corporation. (traffic management) MONUM DoIT	Innovation District and Mayor's Office of New Urban Mechanics to cultivate civic and private sector collaboration in innovation, online game- like platform to engage community in policy and planning, web-based "Adopt a Hydrant" community program, Smarter Cities Challenge Grant traffic management
Edinburgh, Scotland. Pavia, Bergamo, Como, Salerno, Cremona, Rome, Rieti, Naples, Foggia, Milan, Italy. Madrid, Spain. Thessaloniki, Greece. Country wise, Singapore.	Creating Smarter Cities [32 - 36]	Edinburgh Napier University. Intelligent Energy e Europe, European Commission. The European Commission. The Singapore Government	Embedding of information and communication technologies in the city. E-Learning, knowledge transfer, and capacity building technologies. Electronically enhanced government services. Smart economy, environment, energy, mobility and governance. Energy storage systems (ESSs). Digital city model. Creating an Intelligent Island.
Stockholm, Sweden	ICT, Planning and Sustainability Stockholm Royal Seaport, Vision 2030 plan Stockholm's Green IT Strategy, Smart, green and innovative solutions, Environmental-IT, Network Infrastructure [31]	Stokab - public infrastructure company Swedish ICT IBM (transportation) Stockholm SRS - City Planning Administration	Dark fiber network with restructured infrastructure / utility service; public wifi in schools; widespread internet access; public education program for homeless; congestion pricing and traffic management; open traffic data encouraging app development industry; waste heat from broadband switching node to heat school
Amsterdam, Netherlands	Economic Development and City Innovation Amsterdam Smart City (ASC) program, e.g: Geuzenveld Sustainable Neighborhood, End User Driven Innovation, Smart Work Center (SWC), ReloadIT [31]	Local technology providers Liander KPN Cisco Liander - an energy company KPN -telecommunications Cisco - ICT provider Amsterdam Innovation Motor - an independent organization promoting innovation, cooperation and new business	Climate Street collective effort of centralized logistics, dimming public lighting, smart metering; Smart Working Centers hot-desk working facilities replacing offices; energy monitoring and management; citizen engagement apps; Car2Go electric car rental; Ecomap neighborhood emissions information
Country wise, Turkey.	Smart Cities Transformation (proposed, ongoing)	Republic of Turkey Ministry of Development	Transforming cities into smart cities using information and communication technology (ICT) in all areas.

Beyoğlu Municipality established the smart city automation system. Information database constituted as a base of services for citizens, houses, and streets. Municipality digitized all paper works along with the previously issued archives.

Works regarding the smart cities transformation in Turkey are in progress. Government of Turkey try to transform all cities into smart cities using information and communication technologies in all areas.

The city must determine the rate of greenhouse gas emissions to prevent climate change and should make policies for sustainable energy consumption reduction. The term carbon footprint is the measure of the harm done to the environment in terms of the amount of greenhouse gases produced by human activities. Although the low level of per capita emissions, the emissions intensity of Turkey ranks 7th in the EU countries. Whereas Turkey releases carbon dioxide to obtain a unit of energy equals to the highest value in Europe. In this case carbon dioxide emission rate of Turkish industry reveals a high dependency on energy sources such as fossil fuels. It could adversely affect the international competitiveness of the state underlined. Turkey is dependent on foreign fossil fuels. Carbon reduction projects can contribute to both regional developments; they reduce dependence on foreign energy, and as well as bring down unit costs of energy. With environmental responsibility and regulations to be adopted by the government, such as the taxes such as carbon taxes, the use of fossil fuels can be restricted. These measures will lead to the usage of the increased level of renewable energy sources and improvement of the environmental quality. Turkey is a very lucky country in terms of renewable energy potential.

5. Conclusion

In public services area, the quality of life and local or central government services in the city have decreased due to the steep increase in population. Making a proper definition increases the number of people who want to live in a smart city. Smart city people will find the opportunity to benefit from more cultural and tourist activities. Many financial institutions, trading firms will begin to take place in this city where the city information system works perfectly. So smart city will increase the value of that brand, smart cities, and hence it will be ahead of the normal city.

Digital, economical, ecological and social smart cities need participatory planning, infrastructure development, also, simultaneous contribution of public, private, non-governmental organizations and citizens, respectively. Information and communication technologies (ICT) help governors, urban planners, and decision makers for collecting temporal and spatial data to use for smart solutions and consequently for the transformation of conventional cities into smart cities. Creating an information society is possible by the implementation of these smart solutions to every province in Turkey.

Therefore, being smart is not only about harnessing the best ICT to achieve optimum results of environmental and social objectives within the cities. It involves careful organization within and across city agencies and departments to complement new technologies and to form sustainable partnerships with technology

References

[1] Mitchell, W. J., Intelligent cities, 5, Knowledge Society - Universitat Oberta de Catalunya, Barcelona, Spain, 2007, http://www.uoc.edu/uocpapers/5/dt/eng/mitchell.pdf

[2] Harrison, C., and Donnelly, I.A., A theory of smart cities, *Proceedings of the 55th Annual Meeting of the ISSS-2011*, Hull, UK, *55,* (2011), 1, pp. 1-15.

[3] Hodgkingson, S., Is Your City Smart Enough?, 2011, pp. 1–36, Ovum. http://www.cisco.com/c/dam/en_us/solutions/industries/docs/Is_your_city_smart_enough-Ovum_Analyst_Insights.pdf

[4] Prado, A. L., da Costa, E. M., Furlani, T. Z., Yigitcanlar, T., Smartness that matter: Towards a comprehensive and human – centred characterisation of smart cities. *Journal of Open Innovation: Technology, Market, and Complexity*, *2,* (2016), 8, pp. 1-13.

[5] González, J. A., and Rossi, A., New trends for smart cities, Open Innovation Mechanism in Smart Cities. European Commission within the ICT Policy Support Programme (Deliverable D2.2.21), 2011, http://opencities.net/sites/opencities.net/files/content-files/repository/D2.2.21%20New%20trends%20for%20Smart%20Cities.pdf

[6] Yigitcanlar, T., Technology and the city: systems, applications and implications. Routledge, New York, 2016.

[7] Caragliu, A., Del Bo, C., Nijkamp, P., Smart cities in Europe, *Journal of urban technology, 18,* (2011), 2, pp. 65-82.

[8] NAS (National Academy of Sciences), Advancing the Science of Climate Change. Expert Consensus Report. Board on Atmospheric Sciences and Climate, The National Academies, Washington, DC, USA, 2010.

[9] Cavada, M., Hunt, D. V. L ., and Rogers, C. D.F., Do smart cities realise their potential for lower carbon dioxide emissions?, *Proceedings of the Institution of Civil Engineers*, Engineering Sustainability, ISSN 1478-4629, 2015.

[10] Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Milanović, N. P., Meijers, E., Final Report: Smart cities Ranking of European medium-sized cities, Centre of Regional Science (SRF), Vienna University of Technology, Vienna, Austria, 2007, http://www.smart-cities.eu/download/smart_cities_final_report.pdf

[11] Cohen, B., What Exactly Is A Smart City?, 2012, https://www.fastcoexist.com/1680538/what-exactly-is-a-smart-city

[12] Abdoullaev, A., Keynote: a smart world: a development model for intelligent cities, *The 11th IEEE International Conference on Computer and Information Technology*, 2011, pp. 1-28.

[13] Nam, T, and Pardo, T. A., Conceptualizing smart city with dimensions of technology, people, and institutions. *Proceedings of the 12th Annual International Digital Government Research Conference*, Digital Government Innovation in Challenging Times, ACM, 2011, pp. 282-291.

[14] Wolfram, M., Deconstructing smart cities: an intertextual reading of concepts and practices for integrated urban and ICT development, 2012.

[15] Lara, A. P., Marques, J. S., Santos, N., Costa, E. M., Projeto Florip@21: a construção de uma região inteligente na cidade de Florianópolis, Brasil, *Proceedings of XV Latin Iberian-American Congress on Management of Technology*, Porto, Brasil, 2013, pp. 1673-1691.

[16] Yigitcanlar, T., Smart cities: an effective urban development and management model? *Australian Planner*, *52,* 2015, 1, pp. 27-34.

[17] ITU, Smart sustainable cities: an analysis of definitions by ITU-T Focus Group on Smart Sustainable Cities, 2014, http://www.itu.int/en/ITU-T/focusgroups/ssc/Pages/default.aspx

[18] Neirotti, P., Marco, A., Cagliano, A. C., Mangano, G., Scorrano, F., Current trends in smart city initiatives: some stylised facts, *Cities*, *38,* (2014), 1, pp. 25-36.

[19] Batty, M., Axhausen, K.W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G. and Portugali, Y., Smart cities of the future, *The European Physical Journal Special Topics, 214,* (2012), 1, pp. 481-518.

[20] Giffinger, R. and Gudrun, H., Smart cities ranking: an effective instrument for the positioning of the cities?, *ACE: Architecture, City and Environment, 4,* (2010), 12, pp. 7-26.

[21] Haeckel, E., *bd. Allgemeine entwickelungs-geschichte der organismen*, 1866, 2, Verlag Georg Reimer.

[22] Albino, V., Berardi, U. and Dangelico, R.M., Smart cities: Definitions, dimensions, performance, and initiatives, *Journal of Urban Technology, 22,* (2015), 1, pp. 3-21.

[23] Vestergaard, L.S., Fernandes, J. and Presser, M.A., Towards smart city democracy, *Geoforum Perspektiv, 14,* (2016), 25, pp. 38-43.

[24] Cities, S., Trace analysis and mining for smart cities: issues, methods, and applications, *IEEE Communications Magazine, 121,* (2013), pp. 120-126.

[25] Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J.R., Mellouli, S., Nahon, K., Pardo, T.A. and Scholl, H.J., Understanding smart cities: An integrative framework, *Proceedings of the 45th Hawaii International Conference on System Sciences, 1,* (2012), pp. 2289-2297.

[26] Glasmeier, A, and Christopherson, S., Thinking about smart cities, *Cambridge Journal of Regions, Economy and Society, 8*, (2015), 1, pp. 3-12.

[27] Djahel, S., Doolan, R., Muntean, G.M. and Murphy, J., A communications-oriented perspective on traffic management systems for smart cities: challenges and innovative approaches, *Communications Surveys & Tutorials, IEEE, 17,* (2015), 1, pp.125-151.

[28] Black, J., Tara, K. and Pakzad, P., Planning and Design Elements for Transit Oriented Developments/Smart Cities: Examples of Cultural Borrowings, *Procedia Engineering, 142,* (2016), pp. 2-9.

[29] Chakrabarty, S. and Engels, D.W., A secure IoT architecture for Smart Cities, *13th IEEE Annual Consumer Communications & Networking Conference (CCNC), IEEE,* 2006, pp. 812-813.

[30] Zanella, A., Bui, N., Castellani, A., Vangelista, L. and Zorzi, M., Internet of things for smart cities, *Internet of Things Journal, IEEE, 1,* (2014), 1, pp. 22-32.

[31] Pike Research, Global Investment in Smart City Technology Infrastructure to Total $108 Billion by 2020, 2011, http://www.navigantresearch.com

[32] Allwinkle, S. and Cruickshank, P., Creating smart-er cities: An overview, *Journal of urban technology, 18,* (2011), 2, pp. 1-16.

[33] Lazaroiu, G.C. and Roscia, M., Definition methodology for the smart cities model, *Energy, 47,* (2012), 1, pp. 326-332.

[34] Calvillo, C.F., Sánchez-Miralles, A., Villar, J., Energy management and planning in smart cities, *Renewable and Sustainable Energy Reviews, 55,* (2016), pp. 273-287.

[35] Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M. and Oliveira, A., Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation, *Future internet assembly, 6656,* (2011), 31, pp. 431-446.

[36] Mahizhnan, A., Smart cities: the Singapore case, *Cities, 16,* (1999), 1, pp. 13-18.

[37] Alcatel – Lucent, Getting Smart about Smart Cities – Understanding the Market Opportunity in the Cities of Tomorrow (Market Analysis), 2012, http://www.tmcnet.com/tmc/whitepapers/documents/whitepapers/2013/6764-getting-smart-smart-cities-market-analysis.pdf