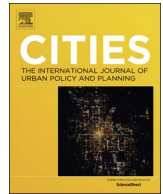




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Centralization or decentralization? A review on the effects of information and communication technology on urban spatial structure

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ABSTRACT

Information and communication technology (ICT) can play an important role in shaping and modifying the urban spatial structure through its effects on the elements and factors that shape this structure. There are many studies that have focused on these effects and studied the impacts of ICT on urban elements and functions. The results of most of these studies are based on arguments about the impacts of these technologies on decentralization or centralization trends in urban spatial structure. In this study, we attempt to categorize the findings of the related studies through a literature review. Although ICT includes conventional communication media such as radio, television, and landlines, here we only focused on new technologies, especially the Internet and mobile phone. For this aim, related studies were searched using wide range of keywords in four scientific information databases for researches published in English and the search period was limited according to the nature of the subject from 1990 to 2017. Subsequently, with the study of the abstracts and the findings of the studies, at last, 80 articles related to the topic were selected for literature review. The result of this review showed that theoretical viewpoints on spatial effects of ICT on urban spatial structure can be categorized into four approaches: A) centralization effects; B) decentralization effects; C) dual effects (both centralization and decentralization); and D) low impact or no effects. The results also indicate that most studies have been focused on the decentralization (42%) and dual effects (33%) impacts, some emphasize on centralization effects (16%), and few studies have also concluded that ICT does not have any effect on the spatial structure of cities or its effects are negligible (9%). Generally, it can be concluded that majority of scholars have consensus that ICT can affect urban spatial structure; what is controversial is only the way of these effects and consequences. Therefore, a proper understanding of the relationship between ICT and the urban spatial structure is essential for urban planners, professionals, researchers and managers.

1. Introduction

Urban spatial structure can be defined as the pattern of spatial distribution of various urban activities (Sohn, Kim, & Geoffrey, 2002), arrangements of buildings, land use, and urban networks (Bourne, 1982; Lynch, 1984; Moudon, 1995); in other word, it is the way city elements are located along each other, which is the result of interaction among complicated forces such as history, politics, land economics, topography, infrastructures, tax system, and urban regulations and policies over time, which can be studied with indicators such as land use, spatial distribution of population and activity, and the daily travel patterns (Dadashpoor, Afaghpoor, & Allan, 2017; Noresah & Ruslan, 2009; Paramita, 2011). This structure is usually measured by the degree of centralization or decentralization (Alberti, 1999). The form and structure of cities also reflects the physical, social, political, economic, and technological conditions and is directly related to the way cities

function. In each period, how to respond to changes and the way in which the existed amenities and tools are used to solve urban problems, can affect the structure of the city. Pre-industrialization city is characterized by features such as diversity, proximity, and density (Höjer, Gullberg, & Pettersson, 2011). The spatial structure of metropolitan areas have evolved in the post-industrialization era (Dadashpoor & Alidadi, 2017) and the nature and form of urban development patterns have considerably changed in this era and constantly is evolving. In the late 21st Century, two important phenomena have occurred: the rapid growth of urbanization and information and communication technology. In the 1980s and 1990s, technological advancements were accompanied by economic growth and this has led to more prosperity, especially in large urban centers. Subsequently, the trend towards urbanization also increased. Urban growth and the occurrence of multiple problems led to the emergence of concepts such as intelligent growth, smart city, e-city, knowledge city, green city and etc. (Dameri &

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Rosenthal-Sabroux, 2014).

The spatial structure of the city changes with new patterns of spatial development due to various factors and the development of technologies is always one of the most important factors influencing development patterns. Stunning technological advances especially in the last two decades have made the shaping forces and factors of today's cities more complicated than ever. These changes have transformed the community and the physics of cities (Portugali, Meyer, Stolk, & Tan, 2012). In the past period, the most important events in the development of technology were the replacement of factories with office buildings and work offices, leading to the transformation of the growth centers and metamorphosis of metropolitan regions as well as developments in computer and telecommunication technologies (Sutriadi, 2011). Today, among the various technologies influencing the urban spatial structure, innovations in ICT have been the most influential ones, despite their short age (Maeng & Nedovic-Budic, 2010), ICT has penetrated all aspects of our life (Alias, 2013); different urban areas have been influenced by this communication systems (Wiig, 2014) and today majority of urban functions are relating to ICT and affected by it (Yin, Shaw, & Yu, 2011). The growing number of communication subscribers, such as the Internet and mobile phones, and the prediction of increasing penetration rate of these networks, represent the emergence of a new behavioral environment (Kimppa, Whitehouse, Kuusela, & Phahlamohlaka, 2014). The massive amount of information emerging from the contemporary electronic cities has given us a new understanding of our lives and the internal dynamics of our organizations and communities. Citizens can produce local knowledge in a bottom-up approach and share information through broadcasted technologies such as smartphones, mobile phones, tablets, and more. By uploading photos, controlling specific places, and sharing georeferenced content, people, as part of their daily experiences, increasingly generate information about how to live, use and understand urban spaces (Ciuccarelli, Lupi, & Simeone, 2014). In any case, the impacts of ICT on the city is undeniable. Despite such changes have drawn attention from scholars in various academic fields, such as geography, economics, planning science, social science, and computer science, and through these debates, the spatial impact of ICTs on regional, urban, industrial and firm development has become a controversial issue (Song & Liu, 2013), however, urban planners have been less concerned with these effects, which is due to the nature of the invisibility of these communications (Batty, 1990; Fernández-Maldonado, 2005; Firmino, 2008), unclear effects of ICT on urban structure, lack of appropriate analytical framework (Audirac, 2005), high speed of related changes to telecommunication in city (Graham & Marvin, 2002), not realizing new technologies as influential factors on urban spatial structure (Firmino, Aurigi, & Camargo, 2006), and scholars' fear of being accused for holding technological determinism (Firmino, 2008). However, nowadays, ICTs are one of the main factors that influence urban development (Stadler, 2013). From a practical point of view, city managers can choose to leverage ICTs to improve services, and hence quality of life, to achieve sustainability goals (Bifulco, Tregua, Amitrano, & D'Auria, 2016). The increasing population density in urban centers requires adequate provision of services and infrastructure to meet the needs of the city's inhabitants, including residents, workers and visitors. The utilization of information and communication technologies (ICT) to achieve this goal provides an opportunity for the development of smart cities, giving city councils and citizen access to a wealth of real-time information about the urban environment upon which to base decisions, actions and future planning (Jin, Gubbi, Marusic, & Palaniswami, 2014). With cities increasingly equipped with all sorts of digital infrastructure and networks, devices, sensors, and actuators, the amount of data they generate has grown exponentially, delivering rich streams of information about cities and their citizens. For the citizens, such big data and their analysis provide insights into city life, support everyday life and decision-making, and enable alternative visions for urban development; for governments, provide more efficient and effective city

administration and regulation; and for businesses, offers new, long-term business opportunities as key players in city government (Kitchin, 2014). Actually, today, technologies are presented as opportunities and supports for more inclusive and informed decision-making processes that is, as a tool, rather than an objective, for effective smartness and sustainability goals (Battarra, Gargiulo, Pappalardo, Boiano, & Oliva, 2016). To unlock and exploit the underlying potential, sustainable urban planning must broaden its boundaries and broaden its horizons beyond the built form of cities to include opportunities for technological innovation (Bibri & Krogstie, 2017). Therefore, the introduction of ICT applications for the development of innovative, sustainable and smart cities has become a new model for urban planners (Yeh, 2017).

Urban planning and its related patterns are based on the position of the city and its social contexts (which constitute a social, economic, and spatial organization for them). The need to respond to existing urban problems along with the emergence of new needs stemming from changes in the social organization of societies as a result of the development of information and communication technology has made it necessary to formulate new approaches in urban planning and design (Kimppa et al., 2014). However, the rapid developments in ICT during last four decades has attracted the attention of many scholars in the field of urban subjects. Many empirical and theoretical studies have also been done about the implications of ICT on urban spatial structure, which have brought about different results. A few studies (Audirac, 2002, 2005; Audirac & Fitzgerald, 2003; Maeng & Nedović-Budić, 2008; Meshur, 2013a; Moss, 1998) have also reviewed the impact of ICT by reviewing the theoretical literature produced in this regard without providing comprehensive analysis of those viewpoints and their results. Focusing on the spatial implications of ICT on the urban spatial structure, with an emphasis on the effects of centralization or decentralization, is one of the most important issues discussed with the implications of these technologies in the city.

This article attempts to examine these effects by studying a wide range of empirical and theoretical researches related to the subject and answer the main questions whether ICT has decentralized traditional concentrated structure of cities. Or has it been able to boost centripetal forces? Or, basically it has had no significant influence on any of these forces and in recent developments of spatial structures of cities, especially metropolises, has not played a significant role? Obviously, accurate response to these questions can improve our understanding of the changes in the urban spatial structure and relationship of ICT to these changes. Given the growing trend of ICT developments, recognizing these effects would be of high importance for planners, decision makers and urban managers.

2. Spatial effects of ICT in city: death of geography/city/distance?

Over the past few decades, new terms and phrases such as networked territories, electronic space, postmodern hyper-space, cyberspace, virtual space, virtual communities, electronic agora, network worlds, etc., were introduced into theoretical literature that show the way of relationship between ICT and its effects on space, city, and community (Al Ani, 2012). Human beings will have new needs according to their daily activities such as housing, leisure, work, and transportation. In accordance with these needs, new infrastructure will also be created, and the result of these transformations will be the change of spatial planning for our living environment (Sariyildiz, 2000). ICT is changing the concepts and paradigms by influencing these activities and changing the way of their undertaking. Telematics information exchange release people from space-time constraints, traffic congestion, and other problems of physical places (Castells, 2005). In "teleportation" something is disappeared from a place and reappears in another place; thus, this form of exchange can cause a collapse of the spatial structure (Kuksa & Childs, 2014). New technologies have also changed the criteria for choosing the location of various activities such as residential areas, workplaces, industries, and manufacturing services

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