Antonio Leone Carmela Gargiulo
Editors

Environmental and territorial modelling for planning and design

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Università degli Studi di Napoli Federico II
Scuola Politecnica e delle Scienze di Base

Smart City, Urban Planning for a Sustainable Future

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This book collects the papers presented at the 10th International Conference INPUT 2018 which will take place in Viterbo from 5th to 8th September. The Conferences pursues multiple objectives with a holistic, boundary-less character to face the complexity of today socio-ecological systems following a systemic approach aimed to problem solving. In particular, the Conference aims to present the state of art of modelling approaches employed in urban and territorial planning in national and international contexts.

This book is the latest scientific contribution of the "Smart City, Urban Planning for a Sustainable Future" Book Series, dedicated to the collection of research e-books, published by FedOAPress - Federico II Open Access University Press. The volume contains the scientific contributions presented at the INPUT 2018 Conference and evaluated with a double peer review process by the Scientific Committee of the Conference. In detail, this publication, including 63 papers grouped in 11 sessions, for a total of 704 pages, has been edited by some members of the Editorial Staff of "TeMA Journal", here listed in alphabetical order:

- Rosaria Battarra;
- Gerardo Carpentieri;
- Federica Gaglione;
- Rosa Anna La Rocca;
- Rosa Morosini;
- Maria Rosa Tremiterra.

The most heartfelt thanks go to these young and more experienced colleagues for the hard work done in these months. A final word of thanks goes to Professor Roberto Delle Donne, Director of the CAB - Center for Libraries "Roberto Pettorino" of the University of Naples Federico II, for his active availability and the constant support also shown in this last publication.

Rocco Papa
Editor of the Smart City, Urban Planning for a Sustainable Future" Book Series
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INTRODUCTION

Between 5th and 8th September 2018 the tenth edition of the INPUT conference took place in Viterbo, guests of the beautiful setting of the University of Tuscia and its DAFNE Department.

INPUT is managed by an informal group of Italian academic researchers working in many fields related to the exploitation of informatics in planning.

This Tenth Edition pursed multiple objectives with a holistic, boundary-less character, to face the complexity of today socio-ecological systems following a systemic approach aimed to problem solving. In particular, the Conference will aim to present the state of art of modeling approaches employed in urban and territorial planning in national and international contexts.

Moreover, the conference has hosted a Geodesign workshop, by Carl Steinitz (Harvard Graduate School of Design) and Hrishi Ballal (on skype), Tess Canfield, Michele Campagna.

Finally, on the last day of the conference, took place the QGIS hackfest, in which over 20 free software developers from all over Italy discussed the latest news and updates from the QGIS network.

The acronym INPUT was born as INformatics for Urban and Regional Planning. In the transition to graphics, unintentionally, the first term was transformed into "Innovation", with a fine example of serendipity, in which a small mistake turns into something new and intriguing. The opportunity is taken to propose to the organizers and the scientific committee of the next appointment to formalize this change of the acronym.

This 10th edition was focused on Environmental and Territorial Modeling for planning and design. It has been considered a fundamental theme, especially in relation to the issue of environmental sustainability, which requires a rigorous and in-depth analysis of processes, a theme which can be satisfied by the territorial information systems and, above all, by modeling simulation of processes.

In this topic, models are useful with the managerial approach, to highlight the many aspects of complex city and landscape systems. In consequence, their use must be deeply critical, not for rigid forecasts, but as an aid to the management decisions of complex systems.

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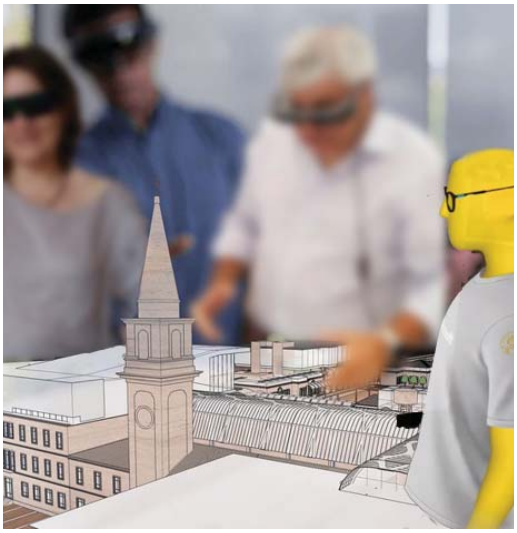

AUGMENTING THE SMART CITY

A "NEW VIEW" FOR THE URBAN PLANNING

ROMANO FISTOLA[a], ROSA ANNA LA ROCCA[b]

[a] Department of Engineering,
University of Sannio
e-mail: romano.fistola@unisannio.it
URL: https://www.ding.unisannio.it/

[b] Department of Civil, Architectural and
Environmental Engineering,
University of Naples Federico II
e-mail: larocca@unina.it
URL: http://dicea.unina.it/

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ABSTRACT

In recent years, Augmented Reality has gained interest both for being a technology that offers many possibilities of interaction with mobile devices (smartphone and tablet) and for its potentialities of being used in outside contexts. The recent transition of Augmented Reality from the virtual context of the Video Games -within an indoor ambiance- to the real urban space -within an outside ambiance- is providing new perspectives for urban planning processes, as a result. Referring to this transition, the paper tries to investigate the possibilities of proposing a new view for the urban planning process taking into account the potentialities of the recent applications of the Augmented Reality. At the same time, the paper wonders on the possibility of new perspectives that the Augmented Reality can offer to the research in the sector of the town planning. Using a methodology based on a systemic approach, the paper intends to underline the relations existing between urban subsystems and the use of technology. In these relations, the social subsystem plays a central role, as its components (people living and using the city) can improve the urban smartness by the adoption of responsible and aware behaviors. AR applications in the field of the game (e.g. the phenomenon of PokemonGo) has shown how people are willing to be involved in new ways of fruition of urban spaces as long as they can use their mobile devices and they can share their own experiences on the social networks. This attitude can be properly taken into account within the process of urban governance both to improve the participative procedures and to explore new paths for the aware use of technologies. These innovative research dimensions should be explored carefully and quickly, considering the possible contribution of these values to the urban smartness.

KEYWORDS
Urban Smartness; City as a complex system; Augmented Reality; Smart and Resilient City

1 INTRODUCTION: THE CONCEPT OF THE SMART CITY

In the last few years, the concept of the Smart City has become particularly prominent within scientific debate, representing an opportunity to renew the way of thinking about cities and their social communities. Early reflections, researchs and projects on this subject seem to converge towards the idea that an urban *smart* development is the inevitable outcome of the infrastructural facilities (physical capital) and their continuous innovation, but it also depends on the quality of the human, social and natural capital, intended as strategic factors of development. In this sense, a *smart city* is, above all, a city capable of both meeting the needs of its citizens and respecting environmental rules. The challenge, thus, is to make the city most responsive to the needs of its users (residents) in terms of better quality of services, reduction of environmental impacts (polluting emissions), and decrease in energy consumption, by using innovative technologies (ICTs) (Caragliu et al., 2011).

From a town planning point of view, this does not seem very different from the visions that some scholars (Cairncross, 1997; Mitchell, 1996) had in the last century about the change in the use of the city due to the spread of new technologies. What characterized this vision was probably the collateral role of the new technologies in the development of urban activities at the economic, social and physical levels. More recently, the theme concerning the role of technology is still being investigated, focusing on the possibility of re-defining the urban functional system using new technologies (Aurigi & De Cindio, 2008; Fistola & La Rocca 2001; Willis, 2007). Up to now, and especially as it concerns the Italian situation, the study of the relations between new technologies and the city has been neglected and probably considered as unrelated to the needs of urban planning. At present, instead, technologies are assuming a significant role, and a renewal of the methods and tools used in approaching the city is required.

The definition of a smart city, thus, can assume different aspects, but the real issue seems to be the informed use of technologies to shift the urban system into a *smart* state. Augmented Reality (AR) can boost this transition, enhancing the dimensions of the real urban system and involving the urban subsystems: the socio-anthropic subsystem, as it allows citizens and city-users to have a new perception of the space; the physical subsystem, as it acts on physical spaces, enriching the real scene with adjunctive information or objects.

1.2 SMART CITY: IS THERE A SHARED DEFINITION?

The emergent "smart city" paradigm seems to highlight that the actual challenge consists in making cities more efficient by means of innovating technologies (ICTs) capable of supporting the management, monitoring and functioning of cities.

The Smart City approach, then, assumes that technology is part of the system and is not an additional element in performing urban activities at different levels (economic, social and physical). In this vision, an *intelligent* city is the one that, using technological innovation, spends less, and in the best way, without reducing the quality of services for citizens and firms.

It is undeniable that ICTs play a central role in most of the Smart City projects developed over the last ten years. Ratti (2012) points out their importance, preferring to refer to a *senseable city*, rather than a smart one, that has citizens at the center of its interest (Ratti, 2012). In this sense, ICTs are the means to allow citizens to act within the city.

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Indeed, definitions of and approaches to the Smart City have not yet reached a common vision (Neirotti et al., 2014) and the smart city seems to be more of an urban label than an alternative approach to urban themes (Battarra et al., 2016; Holland, 2008). Papa et al. (2015) have investigated the lexical connection between the words "smart" and "city," underlining the disparities of complexity between them. The analysis, considering roughly 156 smart city definitions, points out the lack of an organic vision of the urban system as a whole that needs attention for the purpose of facing its present challenges (climate change, energy conservation, CO_2 emissions, etc.), rather than an excessive trust in technologies. Concerning the requirement of a systemic vision, Giffinger et al. (2007) state that a smart city "*is not used in a holistic way (…) but for various aspects, which range from Smart City as an IT-district to a Smart City mainly referred at the level of education of its inhabitants.*"

Even though the combination of technological and social components is gaining increasing attention, two different groups of interest can still now be identified in defining the smart city: the industrial and the scientific. The first group has major interest in equipping the city with sensors; the second group should point out methods and techniques able to support urban planning. Currently, contributions are mainly oriented towards defining urban indicators to "measure" whether and how a city is "smart" (Cohen, 2012; European House Ambrosetti, 2013; Testa, 2012; Wien University of Technology, 2012). Rarely do contributions refer to a holistic vision of urban smartness; a vision applied per part (smart building, smart district, smart street, smart infrastructure, etc.) seems to prevail. However, a holistic vision should allow for positive effects through both technologies and social capital (Fistola, 2013; Papa et al., 2013; Ratti & Townsend, 2011). The availability of a good level of human capital, in fact, is considered a factor of competitiveness and territorial capacity of attraction. The active role of the human factor (the anthropic system: the urban actors, residents, city users, tourists) is also becoming increasingly important, because it can significantly affect the success/failure of a city.

In the context of these considerations, this paper examines the relationship between new technology and the city, considering the dimension of games as a phenomenon that must be observed in order to allow urban planners to face the radical changes occurring in present-day cities. The paper concludes by pointing out the possibilities that the use of gamification and augmented reality can offer in improving the town planning process for a real transition towards urban smartness.

2 METHOD AND MATERIAL: THE CITY AS A COMPLEX SYSTEM AND THE TECHNOLOGICAL PUSH

Many scholars (Allen, 1997; Ashby, 1956; Batty, 2005; Bertuglia et al., 1987; Bertuglia & Vaio, 2011; Mc Loughlin, 1969; Nijkamp & Reggiani, 1993; von Bertalanffy, 1968) have argued that the complexity of cities allows us to consider the city as an open and complex geospatial system (Tab. 1).

The theoretical method of the complex systems could be applied in studying the evolution of the urban systems.

Complexity represents the strategic factor able to ensure the evolution of the system itself. To reduce the complexity of the system and to understand its mode of working, the urban system can be structured into different subsystems that are connected to each other.

In particular, according to the aim of this study, we refer to the city as being constituted of five subsystems that are composed of material and nonmaterial elements (Fig. 1). Subsystems are part of a whole that is the urban system and they cannot be ultimately be separated.

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City and the Complex System Properties	
Multiplicity of elements composing the urban system	Complex systems are made of multiple elements, with different characteristics, functions and structures. Within an urban system, there are material elements (buildings, squares, streets, etc.) and nonmaterial elements (behaviors, economies, societies, etc.). The connections among these elements can vary, differ and diverge: the quality and the types of connection compose a huge and complex system known as the city.
Multilayer structure of the urban system	The vision of the city as being composed of multilayers has recently been affirmed. This vision can be helpful in understanding the complexity of the urban system. The number of layers is strictly connected to the level of complexity of a system: the more layers, the greater the complexity. The layers include people, families, neighborhoods, streets, communities, and districts, and they compose different subsystems that, in turn, are created by elements and connections. A city can be intended as a complex n-dimensional system in which the n-layers-subsystems represent its dimensions.
City as an open system	As a complex and dynamic system, a city is not in a state of equilibrium. According to non-equilibrium self-organization theory, openness is a crucial condition for the system to evolve towards a balanced state, even though it is a dynamic state of balance. The urban space is a typical open system with a dissipative structure: it maintains connections with outside-producing entropy in the form of waste and non-recoverable energy. Nevertheless, openness and dissipation are basic conditions for complex systems.
Adaptivity and inner dynamics	People are the most important elements within the urban system. As individuals, they are active and adaptive (CAS theory), and these characteristics are the main form of complexity. The adaptiveness of an urban system causes inner changes affecting the population, economics and social dynamics of the city.
Nonlinear interactions	Within the urban system, nonlinear interactions are generated among subsystems and inside of them (i.e., the allometric relations between population and area). Nonlinearity is the main cause of the complexity of the urban system.
Self-organization of the city	As a complex system, the city is characterized by self-organization, and its evolution does not depend on external factors. The components of the system (the agents) transform themselves according to simple and internal rules; lacking a global vision of the total evolution of the system, nevertheless, they tend towards a state of equilibrium, moving from chaos to order.

Tab.1 Analogies between complex systems and the city

If the city is a complex system, it is not possible to plan the system's future state, as it is complex, non-linear, and stochastic. Therefore, the only way to lead the system towards a sustainable state, compatible with the limited availability of resources, is to manage its evolution in an attempt to minimize the entropy emitted during its evolutionary process (Fistola & La Rocca, 2013).

Among the urban subsystems, the *social subsystem* represents one of the *generative* systems of the city, and its components are both the peoples living in and using the city (static component) and the connections (dynamic component) among them.

2.1 THE SOCIAL SUBSYSTEM AND THE INNOVATION TECHNOLOGY

Focusing on the social subsystem, it is possible to observe that citizens' behaviors have deeply changed because of the technological revolution and the diffusion of the Internet. People are rapidly modifying their habits by introducing the use of new technology into their daily lives. At the end of 2017, the Internet penetration rate in Europe was about 85% of the total world population (Fig. 2).

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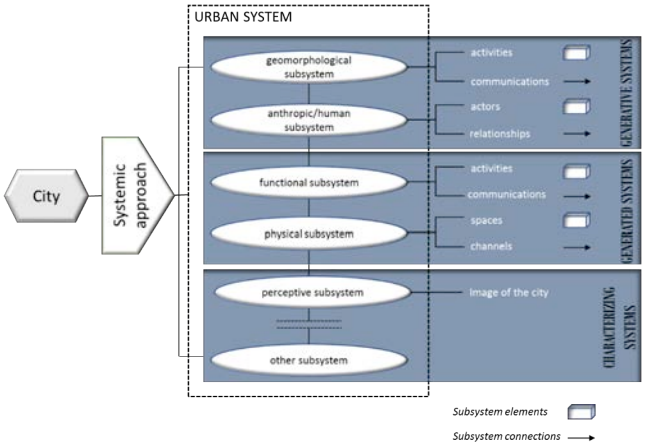

Fig. 1 The urban system and the five sub-systems identified

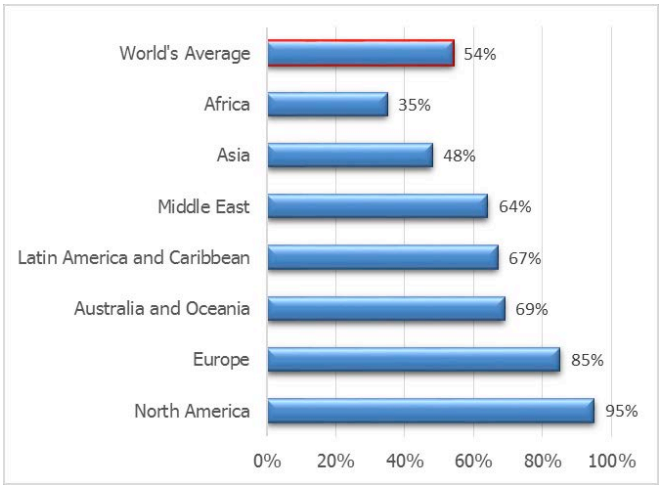

Fig. 2 The Internet world penetration rate per regions calculated on a population of about 7 billion of people (source www.internetworldstats.com, accessed in June 2018)

This means that, around the world, the number of connections to internet and the consequent consumption of data are increasing at a rate double that of the birth rate (Fig. 3).

As a matter of fact, technological interaction has taken over a significant portion of the dynamic of human relationships. An example can be the "Facebook effect" on our interpersonal relationships and the importance in social implication assumed by the number of "likes" to gain a social assent (Reich et al., 2018). It is also possible to state that technological revolution impacts each urban subsystem and especially the social subsystem. Important is to manage the change instead of try to hinder it.

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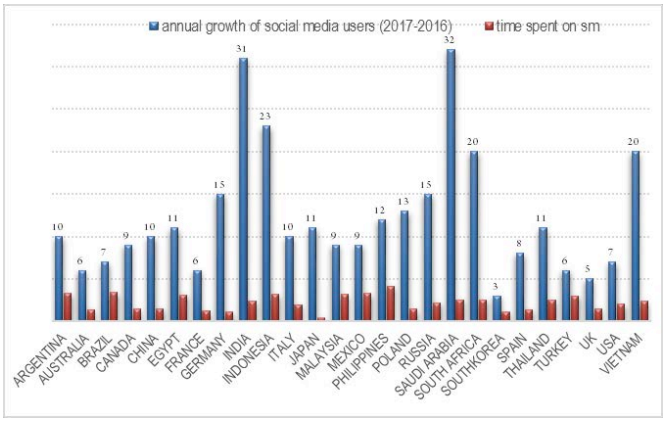

Fig. 3 Percentage of the growth of users of social media (Facebook, and others) and average of time spent per day (survey of users aged 16-64; source Digital in 2017 www.wearesocial.com, accessed in June 2018)

So far, games, software and apps have changed our lives deeply. This also depends on the level of attention that we devote to the technological dimension through our personal digital devices. The technological convergence that considers the smartphone as a tool useful for receiving, elaborating on and exchanging data and information has determined the vital function of every personal device. Furthermore, the diffusion of social networks has created a personal cyber dimension to which it is hard to renounce: nowadays, it is tough to resist answering our mobile when we receive a message (SMS, WhatsApp, Instagram or other), even in the most improbable situation. The use of the smartphone has been also considered as an addiction (South University, 2013). Some scholars in psychology (Gibson 2011; Merlo 2007; Yadav & Yadav, 2016), in fact, have observed certain problematic behaviors due to the excessive use of smartphones (absence of perception of reality and surroundings, aversion to socialization, loss of face-to-face relationships). They remark that the problem could become as serious as substance abuse, even though, obviously, the consequences on health are deeply different. The *cyberkrank* (Spitzer, 2016), thus, also seems to have infected people when they are in a group, at close range, and they cannot help but use their smartphones rather than communicate with each other, driven by the need to be "connected." At present, it is possible to say that technology has a high level of attention in everybody's life and that a significant portion of our daily activities has changed due to the technological push.

2.2 VIRTUAL WORD AND AUGMENTED CITY

The extreme impact of technology on the social system is quite likely the growth of a parallel dimension to which correspond the born of a new urban subsystem: the communicational one (Fistola, 2001).

From the first studies dealing with the urban transformation of the city, due to the Innovation Communication Technology (ICT) at the end of the 90s with the seminal books by Steve Ghrahm in UK (Graham & Marvin, 1996), William Mitchell in USA (Mitchell, 1996) and, before all, the researchers led by Corrado Beguinot and his research group in Italy (Beguinot, 1989), we are now in a new phase of the development process. In this step all the urban subsystems are affected by ICT and the urban system as a whole evolves in time and space by generating an enormous quantity of data (big data) collected by artificial and anthropic sensors.

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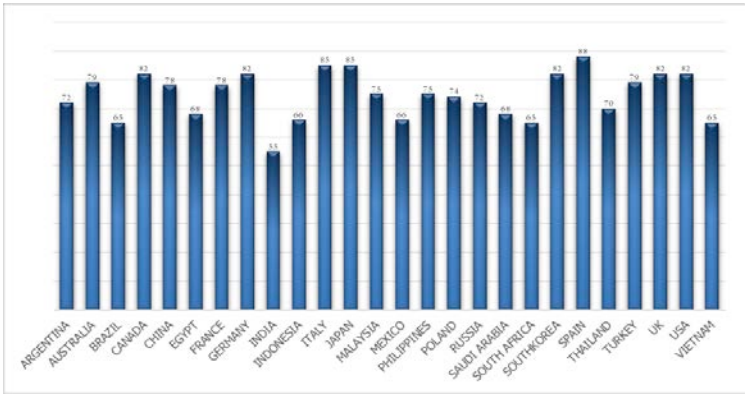

Fig. 4 Percentage of mobile user penetration per country compared to national population, 2017 (source Digital in 2017 www.wearesocial.com, accessed in June 2018

At this time thanks to ICT everybody can participate in the development process of the city by writing a piece of the urban open source code (Carta, 2018). In order to play this role urban actors, (the components of socio-anthropic subsystem), can amplify theirs faculty to envisage a future dimension of the city by "seeing", in the present spaces (physical subsystem), a new composition and a different allocation of urban activities (functional subsystem). The augmented reality (AR) offers this possibility in a more efficient way of the virtual reality (VR), that in the last decade has polarized the attention of scholars and company (for the potential implementation for the videogames). The AR, instead of the VR, allows players to remain in the real physical space and to have experiences that have nothing of either a physical or a real dimension. In other words, the experience of the augmented reality (probably could be more correct to speak about: mixed reality) allows persons in a real social system to interact in a real and physical, but "augmented," city (Tab. 2).

Virtual Reality	***Augmented Reality***
It replaces the real world	It enlarges the scene, but the action occurs in the real world
It replaces the real scene through the building of a virtual ambience	It enriches the real scene through information aimed at solving complex tasks
The visual feedback is totally controlled by the digital system	The visual feedback is mixed (partly controlled and partly not)

Tab. 2 Main differences between Virtual Reality (VR) and Augmented Reality (AR)

By considering the worldwide (but ephemeral) success of the game called: "Pokemon GO" in 2016, in which the players have to catch the Pokemons going around inside the city, forming hunters groups, and looking for preys in a specific places of the urban context (like monuments, historical sites, and so on), the game, thus, could be a new way to drive technology within the city and to affect the citizen's ongoing life (Cecchini, 1993). Maybe, playing an urban game will become a way to make it possible, in the very near future, to drive new behavior and define a new way of interacting with the urban subsystems. On this concept, Pablo Chillon (2012) has argued: "the continuous *dripping* of game-like initiatives in urban contexts, and the increased participation of full engaged multi-players can also help to create new opportunities for business

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and green economies" (Chillon, 2012). The augmented city, thus, can represent a new development phase of the smart city, in which technology allows the citizens to really see the modifications of their urban system and offers them to be involved (meant as active participation) into the urban choices, by overcoming difficulties due to the understanding of technical documents or project. The AR offers also new possibilities in all the phases of town planning: for instance via telepresence, it is possible for planners, who are physically locates in different places, to work together on their tridimensional project. In this regards, it is possible to remark that the ICTs are radically changing the town planning process. This process have to bicome a management process in which the development of the urban system can be monitored through the appropriate use of the big data and the trend of the city can be foreseen by the correct application of the new technological innovation such as AR, VR, 3D city modeling, BIM-GIS and so on.

3 RESULTS AND DISCUSSION: AR AND THE NEW URBAN PLANNING

Remaining within the boundaries of the real city, the AR affects all the urban subsystems: the social subsystem, the functional subsystem and the physical subsystem. At the same time, the psycho-perceptive subsystem (Lynch, 1960) is also involved, if we consider that the AR supports the real world with additional information and does not build a new world avulsed from the real one (Webster et al., 1997). Some scholars envisaged this capability to establish a correct balance between new technology and the management of city transformations (Aurigi & De Cindio, 2008). The augmented reality will allow urban planners to consider the opportunities and risks connected to urban transformation, permitting them to preserve fundamental resources. By using augmented reality, it possible to redefines the urban space (in its physical and functional organization). The gaming dimension could be significant in this sense. The new games that adopt AR allows players to meet in the real space by demolishing the solipsistic attitude of the canonic videogame. There is something that has been radically changed: the urban system has become the physical context of the game. Considering Pokémon Go as a phenomenon that can synthetize the relationship between the use of new technologies and the city, it is possible to point out some positive and negative issues affecting the urban subsystems (Tab. 3).

Urban subsystems	***Positive effects***	***Negative effects***
Physical subsystem	Outdoors vs Indoors Push to explore the city New landmark locations	The consideration of the city as a mere playground The lack of attention to urban patterns
Functional Subsystem	Use of geospatial disciplines and innovative procedures to map the city Support for administrators in monitoring city representation Improvement of urban points of interest, including for the promotion of tourism to the city Monitoring of landmark locations Updating of information about the state of the city Improvement of urban requalification policies	Scarcity of planning the events to catch the monsters Personal security Illegal use of personal data Capturing of personal data Careless behavior in regard to urban automotive traffic Uncontrolled overcrowding
Social-anthropic subsystem	The elimination of "digital solitude" Push to meet people outdoors and create communities	Resident acceptance Personal security Capturing of personal data Social competition Increase in aggressiveness

Tab. 3 Positive and negative effects affecting the urban subsystems

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Positive as well as negative effects can be considered in the implementation of urban policies aimed at improving urban requalification and global urban livability (La Rocca, 2015) . The case of Pokémon Go allows us to consider that the game generates new urban ways of achieving fruition of the city, improving participative processes and allowing people to develop new relationships that materialize within the social network.

4 CONCLUSION

The digital revolution is still in progress and it will produce further modifications inside the human relations, too. Moreover, it is important to take into account that some phenomena involve directly the urban system.
Technological innovation is bringing about the miniaturization of devices and magnification of the space of action: from Eniac (which occupied a surface of 200 sqm.) to the personal mobile phone, and from the game room to the city. As Batty (2013) stated, "the digital revolution has moved computation from the main frame to the smart phone and has seen digital usage spread out from the laboratory to the city, the nation and the globe". Another interesting phenomenon relates to the *wearability* of technological devices that are progressively finding the ways to be integrated with the human body.
In this regard, it is possible to imagine that the future smart city will have an "augmented dimension" that will be possible to explore, using wearable devices, while walking, living, using the "real city". These new trends will foster urban smartness towards increasing levels by spreading technology inside the city and all around us. The AR allows us to share a real space in which to define a virtual comparison; space and mind come together in a new digital environment for the development of collective intelligence (De Kerchove, 2015).
The main aim is to create connections so that the digital flows will build the future city and will redefine all urban functions. In this scenario, the role of the social subsystem will be decisive. People will use the city in innovative ways thanks to the AR and maybe urban gamification, which will allow them to explore physical spaces enhanced with new content.
The interest of the urban planner, connected to the informed use of AR, is the object of recent applications, as of now. The "Urban Plan AR" developed at Heriott Watt University, for instance, is an interesting first application. The app developed by the research group, allows town planners and designer to depict the future transformation of an urban area using the AR, having the opportunity to verify ex-ante the efficiency of their project. Furthermore, this opportunity can facilitate the participation of non-expert users in the decisional process of transformation. This example could give an idea of the potentialities that ICTs offer to urban planning, both in the project phase and in the decisional phase. This is the sense, in our opinion, to consider that technologies are the key factors for generating a real "new" urban smartness.

ACKNOWLEDGEMENTS

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AUTHOR'S PROFILE

Romano Fistola, associate professor of Urban Planning Technique and Government of Territorial Transformation at the University of Sannio. His researches concern the field of city and territory sciences focusing on three main topics: the relationship between technological innovation and urban transformation, urban and territorial risk, the systemic interpretation of the city. He is author of about 120 publications.

Rosa Anna La Rocca, Ph.D., associate professor in Town Planning at the University of Naples Federico II . Her research activities mostly focus on three lines: the relation technological innovation and urban transformations; integration between city, mobility and environment, particularly referred to the sustainability issues; urban phenomena that can impact the organization of urban systems, especially refereed to the tourism activities inside the city.

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Antonio Leone is full professor of Environmental and Territorial Engineering at the Tuscia University. Degree in Civil Engineering. Member of the Teaching College PhD "Land and Urban Planning" at Politecnico di Bari and "Environment and landscape design and planning" at Sapienza University of Rome. Participant and responsible in several projects financed by the European Union within 5th Framework Programme, Interreg IIIB Research Program, COST-actions, LIFE programme and other national and regional research programs (e.g. Nature 2000 sites). Member of Scientific International Committee for Metropolitan Strategic Master Plan "Terra di Bari". Author of about 150 papers and scientific articles on the main international journals related to the management of the environment and landscape and to the engineering of the territory, for the most part of which he also carries out the activity of an anonymous reviewer.

Carmela Gargiulo is full professor of Urban Planning Techniques at the University of Naples Federico II. Since 1987 she has been involved in studies on the management of urban and territorial transformations. Since 2004, she has been Member of the Researcher Doctorate in Hydraulic, Transport and Territorial Systems Engineering of the University of Naples "Federico II". She is Member of the Committee of the Civil, Architectural and Environmental Engineering Department of the University of Naples "Federico II". Her research interests focus on the processes of urban requalification, on relationships between urban transformations and mobility, and on the estate exploitation produced by urban transformations. On these subjects she has co-ordinated research teams within National Project such as Progetto Finalizzato Edilizia - Sottoprogetto "Processi e procedure" (Targeted Project on Building – Subproject "Processes and procedures), from 1992 to 1994; Progetto Strategico Aree Metropolitane e Ambiente, (Strategic Project Metropolitan Areas and Environment) from 1994 to 1995; PRIN project on the "Impacts of mobility policies on urban transformability, environment and property market" from 2011 to 2013. Scientific Responsible of the Project Smart Energy Master for the energy management of territory financed by PON 04A2_00120 R&C Axis II, from 2012 to 2015. She is author of more than 130 publications.

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