Urban Planning and Smart Cities: Interrelations and Reciprocities

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Abstract. Smart cities are emerging fast and they introduce new practices and services which highly impact policy making and planning, while they co-exist with urban facilities. It is now needed to understand the smart city's contribution in the overall urban planning and vice versa, to recognize urban planning offerings to a smart city context. This chapter highlights and measures smart city and urban planning interrelation and identifies the meeting points among them. Urban planning dimensions are drawn from the European Regional Cohesion Policy and they are associated with smart city's architecture layers.

Keywords: Smart city, digital city, sustainability, urban planning, regional planning.

1 Introduction

Regional planning concerns the context and the organization of human activities in a determined space via taking into account the available natural resources and the financial requirements. Urban planning particularizes regional planning in a residential area. Both regional and urban planning are policy frameworks that reflect the Government willing for sustainable land uses and development in a specific space for a limited time period [6], [9], [12], [14]. Planning accounts various parameters such as the environmental capacity, population, financial cohesion, and transportation and other public service networks.

Smart cities appeared in late 80s as a means to visualize urban context and they evolve fast since then. Today, they enhance digital content and services in urban areas, they incorporate pervasive computing and they face environmental challenges. Various international cases present alternative approaches to the smart city, while they capitalize the Information and Communication Technologies (ICT) for multiple purposes, which vary from simple e-service delivery to sophisticated data collection for municipal decision making. South Korean smart cities for instance, use pervasive

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computing to measure various environmental indices [15], which are used by the local Government to carry out interventions for the improvement of life in the city (e.g. for traffic improvement).

This chapter is inspired by the co-existence of the smart city and the urban space, and seeks to investigate the relation between the smart city and the urban planning, in terms of mutual support and benefit. In order for this relation to be identified, an analysis of these terms and of their structure is performed, and the points of mutual interest are recognized. Moreover, this chapter addresses the Future Internet application areas that comprise out of user areas and communities, where the Future Internet can boost their innovation capabilities. In this context, various smart city's infrastructure and applications can contribute to urban planning data collection and decision making by the planning stakeholders' groups.

In the following background section the notions of regional and urban planning are described and the planning framework is outlined on the basis of the European practice. Moreover, the smart city context is clarified, along with a classification of various metropolitan ICT-based environments which are further evaluated according to a generic architecture. Section 3 identifies and summarizes interrelations between urban planning and smart city contexts. The final section 4 has the conclusions of this chapter and some future implications.

2 Urban Planning: Principles and Dimensions

Various relations configure an urban space, such as financial, environmental and social [14], which extend the notion of a city beyond a simple land formulation. Urbanism exist for more than 5,000 years and cities were formed according to variants such as the physical topography, the distance from and the position of the sea, the ordinance of rivers and the transportation networks that connect cities. Forms such as disorder, radius planning, Hippodamus planning and metropolis are the most usual [14]. In the mid-19th century the urban and the regional planning arose as a reaction against the industrial cities, in order to provide with some rules for environmental and for cultural protection, and to determine future national development.

Legislation authorizes the State to control planning's implementation and it defines the **dimensions** of the regional and the urban planning (depicted in Fig. 1) [1], [7]. These dimensions meet built environment dimensions [9] and they refer to the following:

- <u>Environmental protection (Quality)</u>: it deals with qualitative criteria such as: livability, environmental quality, quality of life [11] and respect on biodiversity. In this context planning delimits the urbanization zones, the seashore and streams;
- <u>Sustainable residential development (Viability Timeline)</u>: it covers the urban viability timeline since it "meets the needs of current generations without compromising the ability of future generations to meet their needs and aspirations" [11];

- Resources' capitalization (Capacity): it concerns both natural and human resources' capitalization with means of optimal demographic allocation and decentralization, water and other natural resources' use, residential and farming allocation etc;
- Coherent regional growth support (History and Landscape): it embraces the urban history and landscape and it is based on various Government programs' planning and implementation, which respect traditional settlements, archaeological areas, forests and parks.

Fig. 1 outlines the dimensions and the hierarchical organization of a representative European regional planning set of frameworks [5], which follows the European directives for sustainable land use and development. According to this suggestion, planning's dimensions are allocated to particular frameworks: (a) the *general framework* for long-term (15 years) national sustainable development; (b) the *regional framework* that focuses on peripheral long-term development; (c) the *special frameworks* that concern specific productivity sectors. Each particular framework contains studies and drawings that determine:

- *Demographic distribution* that concerns the Capacity dimension;
- *Land uses* that meet the Quality and the History and Landscape dimensions;
- *Transportation and other utility infrastructures* that align to Capacity dimension;
- *Forests and parks* that concern both the Quality and the Viability Timeline dimensions;
- *The environmental protection framework* that contributes to the Quality dimension;
- *The authorities that monitor and evaluate the planning rules* that meet all of the framework's dimensions.

In this context, the regional planning [5], [11] seeks to protect the environment and to secure the natural and cultural resources, while it highlights the competitive advantages of different areas. Moreover, it strengthens the continuous and balanced national development via taking into account the broader supranational surroundings. Finally, it focuses on financial and on social national cohesion via signalizing particular geographic areas with lower growth rates.

As highlighted in Fig. 1, urban planning particularizes the regional planning in cities and residential areas, it is composed and managed by the local Governments [5], and it is realized via three core plans (Fig. 1):

- The *master plan* for the metropolis.
- The *general urban plan* for the residential and for the suburban organization of the cities and towns. It consists of various studies such as the *urban study*, the *implementation act*, the *rehabilitation studies* etc.
- The *space and residential organization plan* for rural areas.

Urban planning controls the development and the organization of a city, by determining the urbanization zones and the land uses, the location of various public networks and communal spaces, the anticipation of the residential areas and the rules for building constructions, and of the authorization of the monitoring and of the intervention procedures. Campbell [6] described the triangle of conflicts (*property, development and resource*) that exist between *economic development, environmental protection, equity, and social justice*, and which the urban planning aim to manipulate.

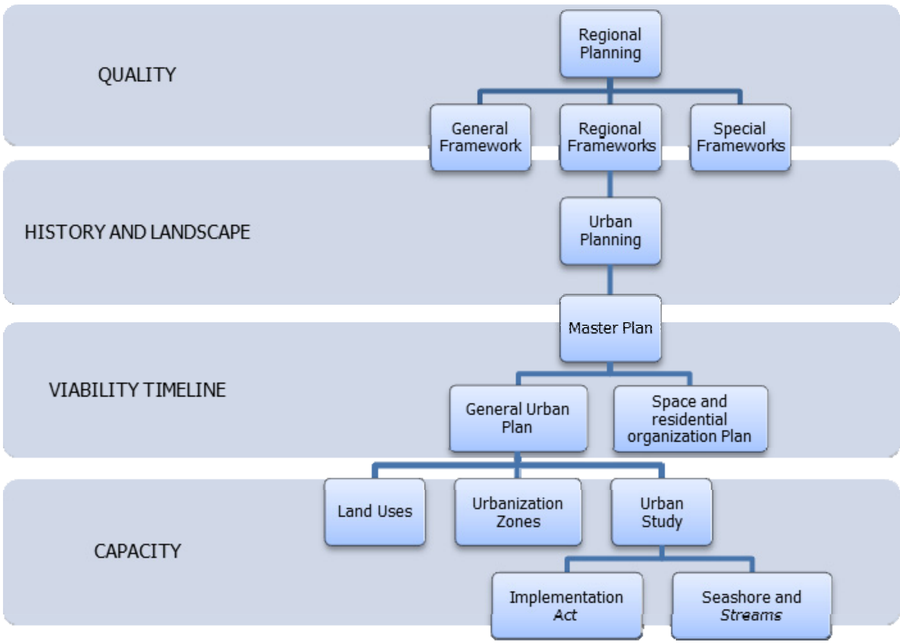

Fig. 1. The hierarchical organization diagram of regional and urban planning's framework

3 Smart Cities: Key Attributes and Characteristics

According to [8] the term smart city is not used in a holistic way describing a city with certain attributes, but is used for various aspects which range from smart city as an IT-district to a smart city regarding the education (or smartness) of its inhabitants. In this context, the smart city is analyzed in intelligent dimension [8], [13], which concern "smart people", "smart environment", "smart economy", "smart governance", "smart mobility" and at a total "smart living".

The term was originally met in Australian cases of Brisbane and Blacksbourg [4] where the ICT supported the social participation, the close of the digital divide, and the accessibility to public information and services. The smart city was later evolved to (a) an urban space for business opportunities, which was followed by the network of Malta, Dubai and Kochi (India) (www.smartcity.ae); and to (b) ubiquitous technologies installed across the city, which are integrated into everyday objects and activities.

The notion of smart city has been also approached as part of the broader term of Digital City by [2], where a generic multi-tier common architecture for digital cities was introduced, and assigned smart city to the *software and services* layer. This generic architecture (Fig. 2) contains the following layers:

- *User layer* that concerns all e-service end-users and the stakeholders of a smart city. This layer appears both at the top and at the bottom of the generic architecture because it concerns both the local *stakeholders* –who supervise the smart city, and design and offer e-services- and the *end-users* –who "consume" the smart city's services and participate in dialoguing and in decision making-.
- *Service layer*, which incorporates all the particular e-services being offered by the smart city.
- *Infrastructure layer* that contains network, information systems and other facilities, which contribute to e-Service deployment.
- *Data layer* that presents all the information, which is required, produced and collected in the smart city.

This generic architecture can describe all the different types of attributes needed to support the smart city context, and which typically include:

- *Web or Virtual Cities,* i.e. the America-On-Line cities, the digital city of Kyoto (Japan) and the digital city of Amsterdam: they concern web environments that offer local information, chatting and meeting rooms, and city's virtual simulation.
- *Knowledge Based Cities,* i.e. the Copenhagen Base and the Craigmillar Community Information Service (Edinburgh, Scotland): they are public databases of common interest that are updated via crowd-sourcing, and accompanied by the appropriate software management mechanisms for public access.
- *Broadband City/Broadband Metropolis,* i.e. Seoul, Beijing, Antwerp, Geneva, and Amsterdam: they are cities where fiber optic backbones -called "Metropolitan Area Networks (MAN)"- are installed, and enable the interconnection of households and of local enterprises to ultra-high speed networks.
- *Mobile or Ambient cities,* i.e. New York, San Francisco installed wireless broadband networks in the city, which were accessible (free-of-charge) by the habitants.
- *Digital Cities* i.e. Hull (UK), Cape Town and Trikala (Greece) extension of the previous resources to "mesh" metropolitan environments that interconnect virtual and physical spaces in order to treat local challenges.
- *Smart or Intelligent Cities*, i.e. Brisbane and Blacksbourg (Australia), Malta, Dubai and Kochi (India), Helsinki, Barcelona, Austin and others of smart-cities networks (http://smart-cities.eu, http://www.smartcities.info): they are particular approaches that encourage participation and deliberation, while they attract investments from the private sector with cost-effective ICT platforms. Today, smart cities evolve with mesh broadband networks that offer e-services to the entire urban space. Various ICT vendors [10] have implemented and offer commercial solutions for the smart cities.

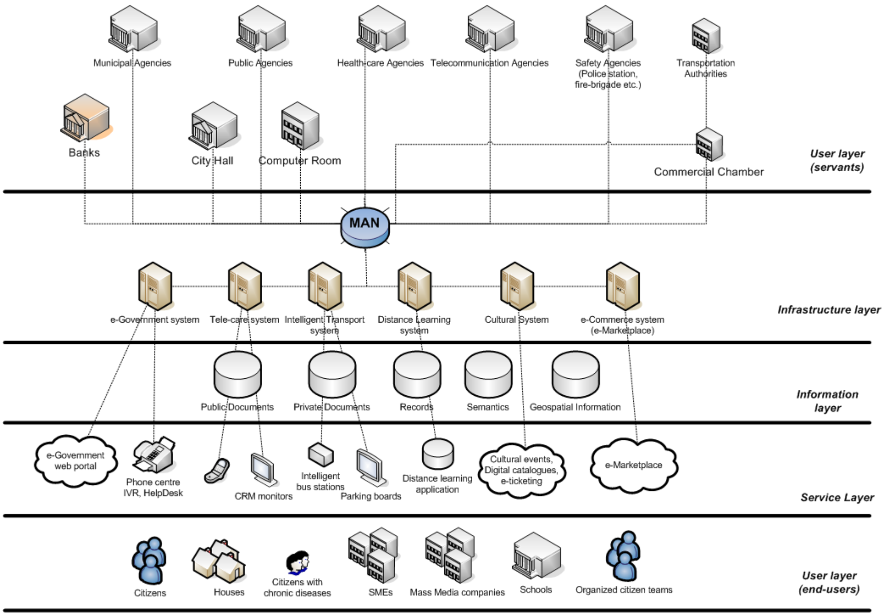

Fig. 2. The multi-tier architecture of a digital city [2]

Ubiquitous Cities, i.e. New Songdo (South Korea), Manhattan Harbour (Kentucky, USA), Masdar (Abu Dhabi) and Osaka (Japan): they arose as the implication of broadband cost minimization, of the commercialization of complex information systems, of the deployment of cloud services, and of the ubiquitous computing. They offer e-services from everywhere to anyone across the city via pervasive computing technologies.

Eco-cities, i.e. Dongtan and Tianjin (China), Masdar (Abu Dhabi): they capitalize the ICT for sustainable growth and for environmental protection. Some indicative applications concern the contribution of ICT sensors for environmental measurement and for buildings' energy capacity's evaluation; smart grids deployment for energy production and delivery in the city; encouragement of smart solutions for renewable energy production.

Table 1. Measuring smart city's sophistication

	Virtual Cities	**Knowl edge bases**	**Broad band Cities**	**Mobile Cities**	**smart cities**	**Digital Cities**	**Ubiqui tous Cities**	**Eco-Cities**
User	5	5	2	1	5	5	5	5
Infrastructur e	1	1	5	5	3	3	5	3
Service	2	1	1	1	5	5	5	5
Data	5	5	1	1	5	5	5	5

The above smart city classification could be evaluated for its sophistication in the following (Table 1), according to the matching of each approach to the generic multi-tier architecture of (Fig. 2). The values of the above table are self-calculated according to empirical findings [2], and they represent the contribution of each architecture layer to the particular smart city approach. The rows of (Table 1) concern the architecture layers, while the columns refer to the abovementioned smart city approaches. The value entries are based on Likert scale (values from 1 to 5) [7] and they reflect how important each layer is considered for each particular approach. On the basis of this measurement:

- User layer accounts significantly in all approaches except in Broadband and Mobile cities, where users mostly consume telecommunication services, while the networks extend to most populated areas.
- The Infrastructure layer does not contribute in Virtual and in Knowledge Based cities, while Smart, Digital and Eco-Cities can mostly focus on e-services that can be deployed either via alternative infrastructure providers.
- The service layer has significant contribution to the approaches beyond the smart city approach, while only a few services are offered in the other approaches. in Virtual City approach the existence of various ICT infrastructure is not necessary, while data and user layers are crucial for city virtualization.
- Finally, the Data layer is the basis for service delivery and thus contributes significantly to all the approaches except from the Broadband and the Mobile Cities, which offer telecommunication services.

These estimated values can support researchers and supervisors in selecting the appropriate approach for their city [3] and to design and predict their city's future "character".

4 Urban Planning and Smart City Interrelations

On the above attributes, various e-service portfolios can be offered in a modern smart city [4]:

- *E-Government services* concern public complaints, administrative procedures at local and at national level, job searches and public procurement.
- *E-democracy services* perform dialogue, consultation, polling and voting about issues of common interests in the city area.
- *E-Business services* mainly support business installation, while they enable digital marketplaces and tourist guides.
- *E-health and tele-care services* offer distant support to particular groups of citizens such as the elderly, civilians with diseases etc.
- *E-learning services* offer distant learning opportunities and training material to the habitants.
- *E-Security services* support public safety via amber-alert notifications, school monitoring, natural hazard management etc.

- *Environmental services* contain public information about recycling, while they support households and enterprises in waste/energy/water management. Moreover, they deliver data to the State for monitoring and for decision making on environmental conditions such as for microclimate, pollution, noise, traffic etc. (in Ubiquitous and Eco-city approaches).
- *Intelligent Transportation* supports the improvement of the quality of life in the city, while it offers tools for traffic monitoring, measurement and optimization.
- *Communication services* such as broadband connectivity, digital TV etc.

The smart city addresses the supranational planning policies - such as the European Cohesion Policy [7] - that influence national planning policies and prioritize transportation networks and accessibility, entrepreneurship, education and training, and sustainable growth. These priorities affect all the four planning dimensions, while the smart city with the intelligent transportation services, the e-business services, the e-learning services, and the environmental services aligns to each of them respectively. The following subsections highlight in detail this relation.

4.1 Smart City to Urban Planning Alignments

Both end-users and stakeholders of the smart city's *User* layer are obliged to follow the planning rules and to consult in cases of framework's construction. Thus, the *User* layer is influenced by all planning dimensions.

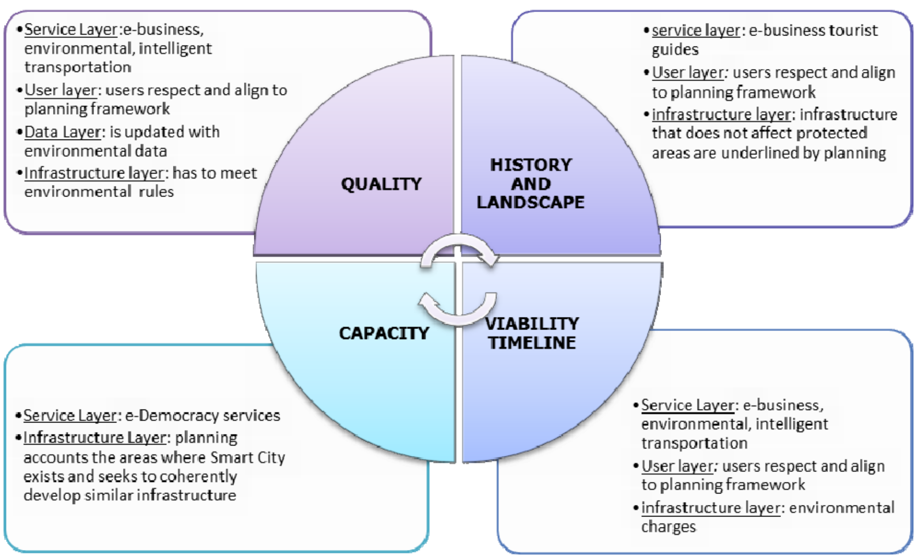

Fig. 3. The smart city's layers align to urban planning dimensions

Moreover, the smart city's infrastructures have to conform to planning rules and not to charge the local environment or the local protected areas, while planning has to uniformly develop smart cities across the regions for coherent development. In this context, the *Infrastructure* layer meets all planning dimensions.

Concerning the *Service* layer, the environmental and the intelligent transportation services align directly to the Quality and to the Viability Timeline planning dimensions. Moreover, the e-Democracy services align to the Capacity dimension, since public consultations and open dialogue can influence planning and express local requirements; planning on the other hand aims to establish resource capitalization for local development that meets local needs. Finally, the e-Business portfolio aligns to the planning dimensions of Capacity and of History and Landscape, since tourist guides demonstrate and can protect traditional settlements, archaeological areas, forests and parks; while business installation services oblige enterprises to install in business centers and in areas that do not influence sustainability.

Finally, the smart city's data layer must be kept up to date with accurate planning information, in order to deliver efficient and effective e-services to the local community. This one way relation between smart city and urban planning is displayed on (Fig. 3) and shows that the development of a smart city has to align to planning dimensions.

4.2 Urban Planning Tracks to Smart City Layering

A vice versa relation exists too (Fig. 4), via which urban planning has to account the existence of a smart city: the environmental data that is collected from ubiquitous sensors has to contribute to Quality and to the History and Landscape dimensions, and useful directions can be considered for land and for residential uses.

Furthermore, the smart city infrastructure layer consists of significant ICT facilities -e.g. broadband networks, computer rooms and inductive intelligent transportation loops-, which influence the Viability Timeline and the Capacity planning dimensions.

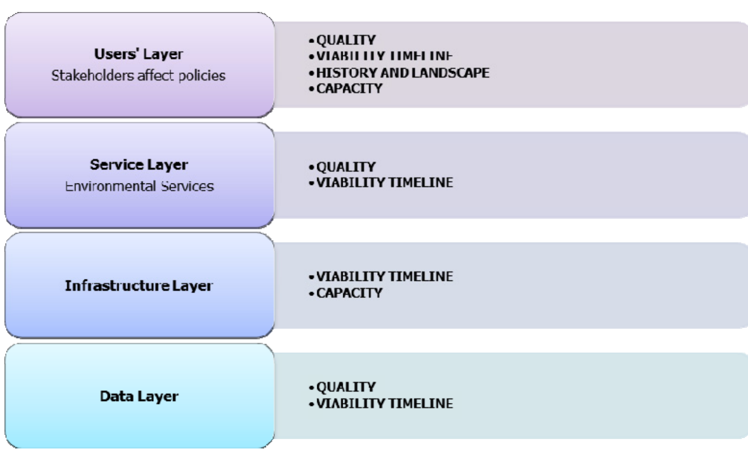

Fig. 4. Urban planning dimensions tracks to smart city layers

All these findings result in a bidirectional relation between planning and smart city (Fig. 3), (Fig. 4), which shows that the smart city aligns to urban planning dimensions, while the urban planning has to capitalize and to respect the existence of a smart city. Furthermore, an important outcome would consider the rate of influence between each urban planning's dimension and each smart city's layer. According to the previous description, the interrelation would be measured with the meeting points between dimensions and layers (Table 2).

The rows in (Table 2) represent the smart city architecture layers, and the columns the urban planning dimensions. The calculated entries in table cells reflect the meeting points that previously discussed. The *Service* layer for instance, meets the four urban planning dimensions; three kinds of e-services address the Viability Timeline dimension, meaning three meeting points (the value of 3) for this cell etc. The *Users* layer meets all urban planning dimensions, since stakeholders can participate in planning, while planning affects stakeholders. The *Infrastructure* layer concerns resources and therefore Capacity in Urban Planning, while the *Data* layer (e.g. environmental data collection via ubiquitous sensors) contributes and must be accounted by the Quality and by the Viability Timeline planning dimensions. On the other hand, the Viability Timeline and the Quality dimensions are mostly affected by the existence of a smart city.

Table 2. Measuring the interrelation between planning dimensions and smart city's layers

	QUALITY	HISTORY & LANDSCAPE	CAPACITY	VIABILITY TIMELINE
User	1	1	1	1
Infrastructure	1	1	1	1
Service	3	1	1	3
Data	1	1	1	1

5 Conclusions and Future Outlook

Smart cities are "booming" and various important cases can be faced worldwide, which can be classified in various approaches and can be evaluated according to their sophistication. All alternative approaches deliver emerging types of services to the local communities with the use of physical and of virtual resources. This chapter considered this co-existence of the smart city and the Urban Space and in this context it investigated the interrelation between smart city and urban planning.

Urban planning supports sustainable local growth, it consists of four dimensions that were recognized according to the European Regional Policy Framework, and their context was described. A smart city on the other hand can follow a multi-tier architecture, which can be considered generic for all particular approaches. The analysis of the planning's dimensions and of the smart city's architecture layers shows various meeting points, via which these two notions interact. More specifically, smart city's service layer aligns and contributes to all the urban planning's dimensions and various e-Services support sustainable local growth. On the other hand, planning's dimensions can be affected by smart city's stakeholders via participatory policy making, while the smart city's infrastructure has to be recognized and capitalized.

This chapter tried to interrelate the physical and the digital space of a smart city with tangible measurement means in order to support Future Internet application areas. Relative efforts have been performed in the South Korean ubiquitous cities, where the smart city moved towards the environmental protection. This chapter's resulted meeting points between smart city's layers and planning's dimensions can provide Future Internet research with details concerning where the developed applications and the deployed infrastructure have to account the physical space and the environment.

General suggestions that require further investigation concern that the smart city has to be accounted in the regional and the urban planning frameworks, with means that the ICT resources are capitalized for information retrieval and analysis for policy making; while the environmental charge of a smart city has to be measured and evaluated during regional and urban planning.

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References

1. Ahern, J.: Planning for an extensive open space system: linking landscape structure and function. Landscape Urban Plann. 21, 131–145 (1991)
2. Anthopoulos, L., Tsoukalas, I.A.: The implementation model of a Digital City. The case study of the first Digital City in Greece: e-Trikala. Journal of e-Government 2(2) (2006)
3. Anthopoulos, L., Gerogiannis, V., Fitsilis, P.: Supporting the solution selection for a digital city with a fuzzy-based approach. In: International Conference on Knowledge Management and Information Sharing, KMIS 2011 (2011)
4. Anthopoulos, L., Tougoutzoglou, T.: A Viability Model for Digital Cities: Economic and Acceptability Factors. In: In Reddick, C., Aikins, S. (eds.) Web 2.0 Technologies and Democratic Governance: Political, Policy and Management Implications. Springer, Heidelberg (forthcoming, 2012)
5. Aravantinos, A.: Urban planning for sustainable growth (in Greek). Symmetria Publishing (1997)

6. Campbell, S.: Green Cities, Growing Cities, Just Cities? Urban planningand the Contradictions of Sustainable Development. Journal of the American Planning Association (1996)
7. European Committee: Regional Policy: Bridging the prosperity gap (2012), `http://europa.eu/pol/reg/index_en.htm`
8. Giffinger, R., Fertner, C., Kramar, H.: Meijers, e. & Pichler-Milanovic, N.: smart cities: Ranking of European medium-sized cities (2007)
9. Handy, S.L., Boarnet, M.G., Ewing, R., Killingsworth, R.E.: How the Built Environment Affects Physical Activity: Views from Urban Planning. American Journal of Preventive Medicine 23(2S) (2002)
10. IBM: How Smart is your city? Helping cities measure progress (2009), `http://www-935.ibm.com/services/us/gbs/bus/html/ibv-smarter-cities-assessment.html`
11. van Kampb, I., Leidelmeijera, K., Marsmana, G.: Urban environmental quality and human well-being Towards a conceptual framework and demarcation of concepts; a literature study. Landscape and Urban Planning 65, 5–18 (2003)
12. Kiernan, M.J.: Ideology, politics, and planning: reflections on the theory and practice of urban planning. Environment and Planning B: Planning and Design 10(1), 71–87 (1983)
13. Komninos, N.: Intelligent Cities: Innovation, Knowledge Systems and Digital Spaces, 1st edn. Routledge, London (2002)
14. Koutsopoulos, K., Siolas, A.: Urban Geography – The European City (in Greek). Greek National Technical University publishing (1998)
15. Lee, S., Oh, K., Jung, S.: The Carrying Capacity Assessment Framework for Ubiquitous-Ecological Cities in Korea. In: 2nd International Urban Design Conference, Gold Coast 2009, Australia (2009)
16. Trochim William, M.: Likert Scaling. Research Methods Knowledge Base, 2nd edn (2006), `http://www.socialresearchmethods.net/kb/scallik.php`