# Evolution Roadmaps for Smart Cities: Determining Viable Paths

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**Abstract:** Smart cities have emerged for more than twenty years from their primary website form to modern ubiquitous and environmental sensitive ones and they encounter an extensive number of representative cases, with an international spread. Today they are considered living labs, areas of smart growth and favorable e-Government environments, while they structure a modern and globalized market with a raising and competitive industry. Various alternative approaches to smart city can be observed, which appeared and have evolved during this timeline. These approaches have attracted various and significant cases, which either evolved to other forms or they later declined. This paper recognizes these different smart city approaches and their evolution, and it seeks to answer the following questions: what different approaches to smart city exist or have existed? How have the smart cities evolved? Do particular evolution roadmaps exist for smart cities? In order to answer these questions, this paper presents a worldwide smart city classification, which describes all the alternative approaches that appear in literature and determines representative city cases together with similarities and differences among these approaches. Literature review is combined with data from an investigation of the official websites of the representative cases, which returns groups of e-services that are being offered by different smart city approaches. These e-service groups are used to identify evolution roadmaps for smart city that can show how smart cities have emerged and to which particular directions are being evolved. The evolution roadmaps are depicted via technology roadmapping tool. Moreover, these roadmaps can become a useful tool for municipal decision makers, who have to choose between evolution forms and smart city projects that secure smart city's viability. Viability is a crucial parameter for every project, especially due to recent financial recession, since smart cities concern extensive and demanding investments, which affect large communities and local life in a significant manner.

**Keywords:** smart cities, technology roadmapping, e-Government, digital cities, e-services, geographies, ubiquitous technologies

## 1. Introduction

Various terms have been used to describe the application of the Information and Communications Technologies (ICT) and the deployment of various e-services in the urban areas (Anthopoulos and Vakali, 2012): *web* or *virtual*, *broadband*, *wireless* or *mobile*, *digital*, *smart* and *ubiquitous* cities are only some of these terms. Moreover, terms such as *knowledge spaces*, *virtual* or *digital communities* extend the physical urban limits and describe groups of citizens who distantly share virtual spaces for a common reason.

No commonly agreed "umbrella" term can be found in the literature to describe this "booming" phenomenon of the abovementioned metropolitan ICT environments, while the *digital city* and the *smart city* ones are the most usual. For the purposes of this paper the term *smart city* will be used to describe all these alternative terms. Smart cities are crucial because, they deal with important state-of-the-art topics i.e., e-Government service delivery, e-service adoption, smart growth, social networking, living labs etc.

Various cities around the world have approached the smart city. Each of them usually faced different challenges and prioritized alternative objectives, such as improvement of local everyday life; development of knowledge-based societies; narrowness of the digital divide; and promotion of e-Government locally (Anthopoulos and Vakali, 2012). Others emphasized on the enhancement of e-commerce services and on local growth, while recently the environmental protection has been put first on the objectives' list.

The implementation of a smart city is based on sets of projects, which address these predefined priorities and objectives. However, these various smart city cases did not keep their initial forms and they have updated – even more than once- to different directions and objectives, a fact that questions the strategic purposes, the effectiveness and the viability of a smart city.

This paper tries to answer the following questions: what different approaches to smart city exist or have existed? How have the smart cities evolved? Do particular evolution roadmaps exist for smart cities? The first question sounds simple, but the appearance of so many different terms that describe the same phenomenon can be confused and the similarities and differences have to be specified. The second question is very interesting, since many smart city cases –i.e., Amsterdam and Barcelona- have changed their approaches even more than twice. and questions rise regarding the reasons that lied behind this change. The third question seeks for answers regarding whether the evolution of smart city approaches is logical and based on technological evolution or it concerns strategic choices and priorities' update.

The remaining of this paper is organized as follows: in the following background section 2 a classification of different smart city approaches is performed. Moreover, representative city cases for each approach are extracted and the evolution of these cases is presented. Then, section 3 structures smart city evolution roadmaps according to the provided e-services. In section 4 this paper's questions are discussed according to the extracted outcomes. Finally, in section 5 some conclusions and some future thoughts are given.

## 2. Background

In this section, a bibliographic review on smart city is performed and many cities appear to follow alternative approaches. Authors combined literature findings with information from the official websites of the extracted cases in order to explore the current condition of the identified cases (Table 1).

According to (Giffinger et al., 2007) 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 mesh metropolitan ICT environments to a city regarding the education (or smartness) of its inhabitants (Giffinger et al., 2007), (Komninos, 2002). Smart city was originally introduced in the Australian cases of Brisbane and Blacksbourg where the ICT supported social participation, narrowness of the digital divide and accessibility to public information and services. Smart City was later evolved to (a) urban spaces for business opportunities, which was followed by the city network of Malta, Dubai and Kochi (www.smartcity.ae); and to (b) ubiquitous technologies installed across the city, which are integrated into everyday objects and activities.

Moreover, smart city has been approached as part of the broader term of digital city by (Anthopoulos and Tsoukalas, 2006), where a generic multi-tier common architecture for digital cities was introduced and assigned smart city to the software and services layer of this architecture. For the purposes of this article, the term *smart city* will refer to all alternative approaches to metropolitan ICT cases.

An investigative literature review returns eight (8) different smart city approaches and 31 representative city cases, which have evolved since the early '90s and faced different challenges. *Web* or *Virtual City* is the primary smart city form with representatives the America-On-Line (AOL) cities (Wang and Wu, 2001), the digital city of Kyoto (Ishida, 2002), (Ishida et al., 2010) and the digital city of Amsterdam (Lieshout, 2001). This approach concerns web environments, which offer local information, online chatting and meeting rooms, and a city's virtual simulation.

The second approach is the *Knowledge Bases*, which was adopted by Copenhagen and then ex-industrial area of Craigmillar (Edinburgh, Scotland) (Van Bastelaer, 1998). Copenhagen developed a public database entitled Copenhagen Base, which had crowd sourcing options, it delivered local information and it was accessible via the Internet and via text-TV. The case of Craigmillar concerns a Community Information Service, which capitalized the ICT to structure groups of citizens who shared knowledge and collaborated to deal with unemployment and with other local needs.

The city of Seoul introduced the third approach entitled *Broadband City/Broadband Metropolis*, where fiber optic backbones were installed in the city and enabled the interconnection of households and of local enterprises to ultra-high speed networks (Townsend, 2007). Last mile connections to the backbone were established with fiber optic channels (Fiber-to-the-Home, FTTH), composing a flourish environment for telecommunication vendors and for private investments in general. Other cities that can be classified in this category is Beijing (China) (Sairamesh et al. 2004), Antwerp (Belgium), Helsinki, Amsterdam and Geneva (Van Bastelaer, 1998). Antwerp and Amsterdam collaborated and interconnected their broadband networks.

Another approach is the *Mobile* or *Wireless* or *Ambient* Cities, with representatives New York City and Atlanta (Ganapati and Schoepp, 2008)-, which installed wireless broadband networks in the city, accessible (with or without charge) by its inhabitants.

*Digital City* extends the above approaches and older ones (Moon, 2002) and describes a “mesh” metropolitan environment that interconnects virtual and physical spaces in order to deal with local challenges. Anthopoulos and Tsoukalas (2006) define the digital city as the “ICT-based environment whose priorities concern a) the ICT contribution to local needs and transactions, b) the transformation of the local community to a local information society, c) the direct and indirect, official and unofficial information collection, in order to support the sustainable development of the local community”. This approach has been followed by various cities such as Hull (UK), Cape Town (South Africa), Tampere (Finland) and Trikala (Greece).

*Smart City* approach was described above and is currently fully applicable in Dubai, where the “media city” (www.dubaimediacity.com) and the “internet city” (www.dubaiinternetcity.com) offer broadband and media infrastructures to the enterprises. Other smart city representatives are Barcelona, Austin (USA), Tampere (Finland) and European cities (http://smart-cities.eu, http://www.smartcities.info), which recognize several dimensions of intelligence to which the ICT can contribute: economy (Smart Economy), education (Smart People), governance (Smart Governance), transportation (Smart Mobility), sustainability (Smart Environment) and everyday life (Smart Living). Various ICT vendors (e.g., IBM, Microsoft, Hitachi and Oracle) have implemented commercial solutions for the smart city approach.

*Ubiquitous City (u-City)* concerns the result of broadband costs’ minimization and commercialization of large-scale information systems, cloud services and ubiquitous computing in urban spaces. U-city has representatives New Songdo (Hyang-Sook et al., 2007) (South Korea), Manhattan Harbour and Kentucky (U.S.A.), Masdar city (Abu Dhabi) and Osaka (Japan), where information is accessible anytime, from everywhere by anybody via ubiquitous ICT. In many cases (i.e., in South Korea and Abu Dhabi) this approach is accompanied with the construction of new urban spaces where pervasive computing will is included from the scratch in buildings.

Finally, the *Eco-city* or *Green City* approach capitalizes the ICT for sustainable growth and for ecological protection. ICT sensors for environmental measurement and for buildings’ energy capacity’s evaluation; smart grids produce energy for inhabitants’ consumption; encourage smart solutions for renewable energy production are only some of the eco-city services. This approach has been followed by New Songdo and Dongtan (South Korea), Tianjin (Singapore) and Masdar (Abu Dhabi), while it is being followed by others (i.e., Amsterdam).

Except from the above approaches, various cities joined networks of common interests to provide with intelligence their urban spaces or to structure virtual teams of collaborative people. Eurocities network (http://www.eurocities.org), Intelligent Communities (www.intelligentcommunity.org), the World Foundation of Smart Communities (http://www.smartcommunities.org) and Community Networks (e.g. the Seattle Community Network (http://www.scn.org)) are representative cases.

**Table 1:** The classification and current status of various smart cities

| Approach | Cases: Started – Current Condition |
|---|---|
| Virtual City | America-On-Line (AOL) Cities (1997- today)<br>Today: City Guides for U.S. cities http://www.citysbest.com<br>Kyoto, Japan (1996-2001)<br>Web prototype finished its experiments by September 2001 http://www.digitalcity.gr.jp<br>Bristol, U.K. (1997- today) http://www.digitalbristol.org/<br>Amsterdam (1997- today)<br>It evolved to other approaches (broadband, smart, eco-city)<br>http://www.amsterdamsmartcity.com |
| Knowledge Bases | Copenhagen Base (1989- today)<br>Today it operates as a city portal http://www.kk.dk and Copenhagen evolved to Eco-City<br>Craigmillar Community Information Service, Scotland (1994- today)<br>It operates as a community portal http://www.s1craigmillar.com<br>Blacksburg Knowledge Democracy, Australia (2001- today)<br>It evolved to the digital city approach |
| Broadband City / Broadband Metropolis | Seoul, S. Korea (1997- today)<br>Evolves with 84% broadband penetration, it is expected to reach 1GB web connections by 2012, and it provides with Wi-Fi access its public buildings (Engadget, 2011)<br>Beijing, China (1999- today)<br>It has been evolved to digital city, which focused on buildings of the Olympic Games 2008 |

| Approach | Cases: Started – Current Condition |
|---|---|
| | (Gauggel, 2011), (Qi and Shaofu, 2001)<br>Helsinki (1995-today)<br>New e-services' deployment on WLAN infrastructure http://www.hel.fi<br>Geneva-MAN, Switzerland (1995 – 2012)<br>It exists and offers broadband connectivity to its inhabitants and local enterprises |
| Wireless / Mobile / Virtual City | New York (1994- today)<br>Exists offers various e-services http://www.nyc.gov/html/doitt/<br>Kista / Stockholm (2002- today)<br>Kista has become a thriving Science City and a leader in mobile and ICT development http://en.kista.com<br>Florence, Italy (2006- today)<br>Exists and a charter is documented for future similar developments http://senseable.mit.edu/florence/ |
| Smart City | Antwerp, Belgium (1995- today)<br>Started as Broadband City and today interconnected to Brussels and to Amsterdam (Baeyens, 2008).<br>Taipei, Taiwan (2004- today)<br>It exists and it evolves to eco-city<br>Tianjin, China (2007-today)<br>It exists and it evolves to eco-city http://www.tianjinecocity.gov.sg<br>Barcelona, Spain (2000- today)<br>Exists, http://w3.bcn.es, http://www.bcn.es<br>Brisbane, Australia (2004- today)<br>Exists and limited its scope to local e-Government, traffic and parking services, and on waste management http://www.brisbane.qld.gov.au<br>Malta (2007- today)<br>Continues to connect ICT companies especially in the field of healthcare and education http://malta.smartcity.ae/<br>Dubai (1999- today)<br>Exists and continues to integrate top ICT solutions<br>Tampere (Finland) (2003-today)<br>It began as a thinking tank for innovative ICT applications. Today it occupies more than 1,000 professionals who develop various e-Services http://www.tampere.fi |
| Digital City | Hull, U.K. (2000- today)<br>Exists and focused on e-Government, on e-learning and on smart TV (http://www.hullcc.gov.uk)<br>Cape Town, South Africa (2000- today)<br>Exists and offers various e-services such as environmental, for tourism, transportation (http://www.capetown.gov.za)<br>Trikala, Greece (2003- today)<br>Exists and limited its scope to tele-care and to metro-Wi-Fi services (www.e-trikala.gr)<br>Austin, U.S.A. (1995- today)<br>Exists and emerges to Eco-City http://www.cityofaustin.org/<br>Knowledge Based Cities, Portugal (1995- today)<br>Portals of the digital cities do not meet projects' objectives http://www.cidadesdigitais.pt |
| Ubiquitous City | New Sondgo, S. Korea (2008- today)<br>Under development and evolves to eco-city (Jackson et al., 2011)<br>Dongtan, S. Korea (2005- today)<br>Evolves to eco-city http://www.udongtan.or.kr/<br>Osaka, Japan (2008- today)<br>Under development (Jackson et al., 2011)<br>Manhattan Harbour, Kentucky, U.S.A. (2010- today)<br>Under development. http://www.themanhattanharbour.com<br>Masdar, United Arab Emirates (2008- today)<br>Under development. http://www.masdarcity.ae |
| Eco-city | Dongtan S. Korea (2005- today)<br>Evolves to eco-city http://www.udongtan.or.kr/<br>Tianjin (Singapore),<br>Under development. Public housing project in the Eco-city and Keppel District Heating and Cooling System Plant http://www.tianjinecocity.gov.sg<br>Masdar, United Arab Emirates (2008- today)<br>Under development. http://www.masdarcity.ae |

Moreover, this investigation identified the following types of e-services that have or are being offered by the examined cases (Table 2):

- *E-Government services* concern public complaints, administrative procedures at local and at national level, job searches and public procurement (they are faced in Digital, Smart and Ubiquitous approaches).
- *E-democracy services* perform dialogue, consultation, polling and voting about issues of common interests in the city area (they are offered by Virtual, Digital, Smart and Ubiquitous approaches).
- *E-Business services* mainly support business installation, while they enable digital marketplaces and tourist guides (met in Digital and Smart city approaches).
- *E-health and tele-care services* offer distant support to particular groups of citizens such as the elderly, civilians with diseases etc. (appear in Digital and Smart city approaches).
- *E-Security services* support public safety via amber-alert notifications, school monitoring, natural hazard management etc. (only available in Ubiquitous approaches).
- *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. (met 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 (delivered in Digital and Smart city approaches).
- *Communication services* such as broadband connectivity, digital TV etc. (offered by Broadband, Mobile, Digital, Smart and Ubiquitous approaches).
- *E-learning and e-education services* (available in Smart and Digital city approaches).

**Table 2:** E-services that are being offered by smart cities

| Case | Started | e-Services |
|---|---|---|
| AOL Cities | 1997 | Online City Guides, Information from local enterprises |
| Digital City of Kyoto | 1996 | GIS information about the city, City Guide, Municipal Transportation, Crowd Sourcing, 3D Virtual Tour |
| Bristol | 1997 | Advertising spaces, Connection with citizens personal sites, Public information |
| Amsterdam | 1997 | Energy Management, Smart Building, Tele-presence Conference Centers, Grid energy solutions, Sustainable Public Spaces, Sustainable Working |
| Copenhagen | 1989 | Local e-Government Services, National e-Government Services, City Guide, e-parking services, Guides for entrepreneurship |
| Craigmillar | 1994 | Self-recycle Services, Local online news, Job opportunities in the city, Marketplace for cars and property |
| Blacksburg | 2001 | GIS services, Crowd sourcing, MAN, 3D Virtual City model with crowd sourcing options, Broadband services, Online guides and training for entrepreneurs |
| Seoul | 1997 | Wired and Wireless broadband internet services, Digital Mobile TV |
| Beijing | 1999 | Wired and Wireless Broadband Services, Smart Olympic Buildings |
| Helsinki | 1995 | Regional Map Service, WLAN hot spots, e-health cards |
| Geneva | 1994 | Wired and Wireless Broadband Services, Public Information and public service guides, Tourist Guides, Job Opportunities, (http://www.ville-geneve.ch) |
| Antwerp | 1995 | e-Government services (e-Counter), Online Tourist Guide, e-Booking Property Database, environmental information and guides for entrepreneurs |
| New York | 2004 | Wireless broadband services, e-Government portal (www.nyc.gov), GIS city information (http://gis.nyc.gov/doitt/nycitymap/) |
| Stockholm (Kista) | 2002 | residential parking permits, e-government services, elderly care treatment |
| Taipei | 2004 | Intelligent transportation, e-parking, 3D website for virtual tours, public e-services, E-Future Classroom |
| Dongtan | 2005 | Eco services like smart grids, energy/water/waste smart management, green buildings |
| Tianjin | 2007 | Eco services like smart grids, energy, water and waste smart management, green buildings |
| Barcelona | 2000 | e-Government services, mobile services, Online city guide, guides for entrepreneurs (https://w30.bcn.cat), Intelligent transportation, Open data from city Council |

| Case | Started | e-Services |
|---|---|---|
| Hull | 2000 | e-Government information and e-services, GIS maps |
| Trikala | 2003 | Tele-care services, Intelligent Transportation, Wireless broadband services |
| Brisbane | 2004 | e-parking, e-Government services, mobile services, e-procurement services via national portal, virtual communities |
| Malta | 2007 | Smart grids |
| Dubai | 1999 | Media services, e-Education, e-commerce, Develops business services |
| New Songdo | 2008 | Intelligent Buildings, Ubiquitous computing, Local information (http://www.songdo.com) |
| Osaka | 2008 | Tourist guides, Public information(http://www.city.osaka.lg.jp), Guides for entrepreneurs (http://www.investosaka.jp) |
| Manhattan Harbour, Kentucky | 2010 | Intelligent Buildings, Ubiquitous computing |
| Masdar | 2008 | Renewable resources and smart energy management |
| Cape Town | 2000 | Environmental services, tourist guides, intelligent transportation |
| Knowledge based cities | 1998 | Broadband and telecommunications services, Online city guides, Public information |

## 3. Visualizing smart city evolution

The above investigation identified the existence of various alternative smart city forms, with representative cases that concern large scale projects, most of which have been evolved for more than ten years. Additionally, these projects can be recognized as ongoing since they have redefined their scope and objectives, even more than once. Furthermore, this classification and analysis illustrates how the examined cases followed the alternative categories; it is determined which of them and when they changed to other smart city approaches and which of the approaches have been the most popular since the smart city introduction (Figure 1).

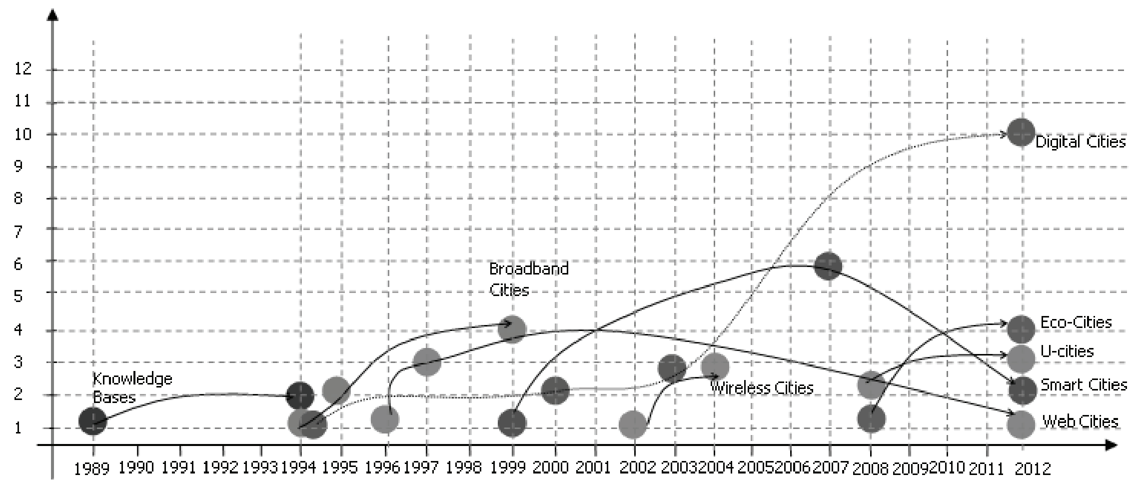


**Figure 1:** Smart city evolution

(Figure 1) illustrates that (a) knowledge bases appeared first and they updated to digital cities. (b) Broadband cities were next on the timeline and they mostly evolve to smart cities. (c) A relative evolution path is followed by the wireless cities. (d) Today, not all of the approaches are available, but the digital, smart, ubiquitous, eco-cities and web cities. Additionally, the evolution path of each alternative approach can be observed. For instance, digital cities appeared in 1994, they are still active and today, they account twelve of the examined cases.

In order to answer the third question of this paper regarding smart city evolution roadmaps, technology roadmapping is used, which is a powerful and flexible technique that is widely used within industry to support strategic and long-range planning (Phaal et al., 2003). Roadmapping provides structured means for exploring and communicating the relationships between technological resources, organizational objectives and the changing environment. Moreover, the path-dependent roadmap (Li et al., 2009; Li and Wang, 2011) that is based on the technology roadmapping has been used to demonstrate several formula changes over time and to interpret how these changes depended on its own past.

In this context, data from investigative analysis that concern the types of e-Services that each of the examined case offers together which of them were adopted by smart cities' updates (Table 2) can be applied on technology roadmapping. The information of (Table 2) generates e-service groups according to their end-users (Table 3). The values that are contained on the year column concern the earliest year, when a smart city case appears and offers e-services from the e-service group; the frequency column enumerates the cases that match each e-service group.

**Table 3:** E-service groups structured by the examined cases

| Service Group | e-Services | Year | Freq. | Cases |
|---|---|---|---|---|
| SGroup1 | e-business, city guides, urban virtualization | 1989 | 6 | AOL cities, Bristol, Copenhagen Base, Craigmillar, Osaka, Blacksburg, Amsterdam |
| SGroup2 | E-Government, e-Democracy, e-learning | 1994 | 9 | Bristol, e-Trikala, Antwerp, Stockholm (Kista), Taipei, Barcelona, Hull, Brisbane, New York |
| SGroup3 | Broadband communications services | 1994 | 14 | Craigmillar, Blacksburg, Seoul, Beijing, Helsinki, New York, e-Trikala, Dubai, New Songdo, Knowledge based cities, Geneva, Barcelona, Amsterdam, Cape Town |
| SGroup4 | E-health and tele-care services, e-security | 1995 | 3 | Helsinki, e-Trikala, Stockholm (Kista) |
| SGroup5 | Intelligent Transportation, e-parking | 2002 | 6 | Stockholm (Kista), Taipei, e-Trikala, Brisbane, Amsterdam, Cape Town |
| SGroup6 | Ubiquitous services, communications services | 2008 | 4 | Osaka, New Songdo, Masdar, Manhattan Harbour |
| SGroup7 | Eco-services, smart grids, waste/recycle management | 2005 | 7 | Amsterdam, Craigmillar, Malta, Masdar, Tianjin, Dongtan, Cape Town |

Data from (Table 3) extract the path-dependent roadmap (Li et al., 2009) of (Figure 2), which demonstrates smart city approaches changes and how each change depends on its own past. Path dependency can explain smart city evolution on the basis of the e-service provision, while paths do not illustrate co-existences of cases in more than one groups (i.e., e-Trikala simultaneously belonged to SGroup1, SGroup2 and SGroup3). Some further findings show that SGroup1 and SGroup2 are root nodes in these paths, while SGroup7 is an end-node, illustrating that this smart city category has not evolved to a different approach yet.

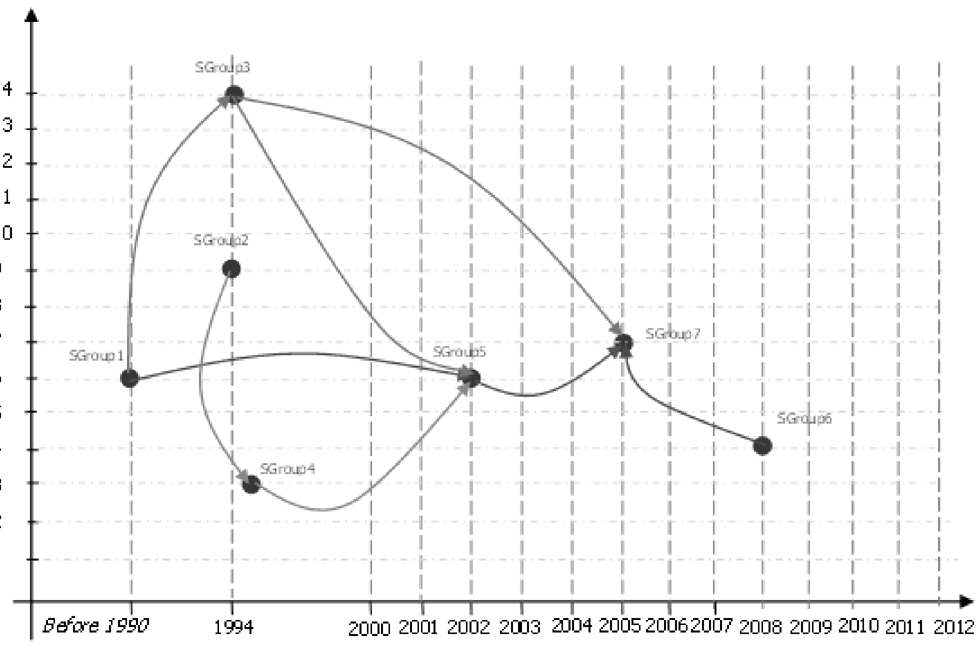


**Figure 2:** Path-dependent roadmaps for smart city evolution

## 4. Discussion

The investigation that was previously presented was performed on a 31 smart cities and returned important findings that answer the questions 1 and 2 of this paper. The term smart city does not describe a city with some particular attributes, but various types of municipal ICT environments. Some researchers have used this term to calculate the intelligence that is produced in urban spaces, while others to depict urban areas that offer smart e-services or encourage the generation of intelligence. The identified alternative approaches generates eight classification groups for smart cities. Another finding confirms that most cases did not retain their initial approach, but they have been updated to other(s). (Figure 1) illustrates the evolution timeline of the smart cities, where five of the smart city categories still exist.

In order to answer the third question of this paper regarding smart city evolution roadmaps, the provided e-services are combined in eight e-service groups (Table 3). Technology roadmapping for these e-service groups shows that smart cities have not evolved to all particular approaches, but five path-dependent roadmaps can be observed (Figure 2). This final finding can be interpreted in the following hypotheses: (a) not all smart city approaches are suitable to be followed by all urban areas, but various parameters could determine to which direction a smart city must evolve. However, it is beyond the purpose of this paper to determine these variants. (b) Not all approaches have attracted smart city evolution, but environmental e-service provision appears the “peak” in recent evolution, while smart cities that provide e-business, broadband and transportation services have also been popular.

These two hypotheses, when they will be confirmed could provide answers regarding smart city viability. Viability stands as “capability of successful operation” (Oxford Dictionary, 2012). This can be interpreted as the “feasibility and the operational continuity of an organization, a business, a facility or a project’s outcome in political, social, legal, environmental, economical, and financial terms” (Salman et al., 2007). Viability should not be confused with sustainability, which can be defined as “the development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations, 1987). Smart city viability is questioned and is not secured, although the project finishes in time, on budget and aligned to its requirements.

Viability has become crucial for municipal decision makers; San Francisco and Chicago mobile cities have been questioned for their feasibility (New Millennium Research Council, 2007); Iowa Communications Network and California CALNET system have failed to secure incomes; Trikala has shortened its scope; or have changed their priorities in order to sustain (i.e., Amsterdam). In Tampere, decision makers prioritized outsourcing for infrastructure deployment and for e-service delivery in order to sustain, promoted only the self-sustained e-services, while the smart city occupies a significant amount of ICT professionals and researchers in order to secure viability via innovation.

From the viability point of view, various determinants have to be considered (Salman et al., 2007): geographical, financial, legal, cultural, technological, social and environmental are crucial for projects’ viability and various indices have to be determined for each of these variants. In this context, the five path-dependent roadmaps that were extracted in this paper align to technological determinants and could support decision makers in dealing with smart city’s prospect. Moreover, although five different smart city approaches exist today (Figure 1), the eco-city has mostly attracted the evolution.

## 5. Conclusions – future thoughts

This paper confirmed that smart city is a “booming” phenomenon, while the term smart city is confusing. An investigative review of 31 cities identified eight classification approaches, five of which are still active, while most of the investigated cases have experienced updates from their initial approach.

Furthermore, technology roadmapping on the examined cases returned interesting outcomes, such as five path-dependent roadmaps for smart city evolution. This paper did not try to recognize the reasons lying behind these paths, but it hypothesized the requirement for viability. Since viability is influenced by a number a parameters, these path-dependent roadmaps can be useful for municipal decision makers in determining their smart city prospect. Some future thoughts concern exploration of the variants that influence smart city evolution and of the factors that make eco-city the most popular, and the determination of viability indices for smart city.

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