

Smart Cities and Standards – the Approach of the Horizon 2020 Project ESPRESSO

Jan-Philipp Exner, Pietro Elisei

(Dr.-Ing. M.Sc. Jan-Philipp Exner, University of Kaiserslautern – Department of CAD & Planning Methods in Urban Planning and Architecture (CPE), Pfaffenbergstr. 95, 67663 Kaiserslautern, exner@rhrk.uni-kl.de)
(Dr. Pietro Elisei, URBASOFIA, Splaiul Independenței 3, Bucurest, pietro.elisei@urbasofia.eu)

1 ABSTRACT

A Smart City integrates physical, digital and human systems to deliver a sustainable, prosperous and inclusive future for its citizens. Many of these innovative solutions will be based on sophisticated information and communication technologies. However, technological complexity, as well as the complexity of the various sectoral services involved within a Smart City, require a system approach to standardisation. Such an approach must promote the greatest possible reuse of existing open standards to accelerate the Smart City deployment. In an effort to leverage the promise of a system approach, the Horizon 2020-project ESPRESSO (systEmic standardisation apPRoach to Empower Smart citieS and cOmmunities) will focus on the development of a conceptual Smart City Information Framework based on open standards.

A further goal of ESPRESSO will be to envisage the impact of those technologies for urban planning and also in societal terms. The partner cities will be engaged to analyse how their services can be streamlined and improved through large-scale use of standards. This will be done by analysing the downstream changes from the new scenarios enabled by large-scale interoperability and what this could bring for a future Smart City. Based on a detailed requirements-engineering campaign executed in close cooperation with cities, standardisation organizations, administrative bodies, and private industry, the project will identify open standards matching the elicited requirements and will establish a baseline for interoperability between the various sectoral data sources and the Smart City enterprise application platform. In a comprehensive set of coordination, support and networking activities, the project will engage a very large number of stakeholders, such as Smart Cities (both existing and those with aspirations), European Standardisation Organizations (ESOs), National Standardisation Bodies (NSBs), Standards Development Organizations (SDOs), public administrations, industries, SMEs, and other institutions. ESPRESSO's approach emphasises cost reduction and will foster an open market for many actors, avoiding lock-in to proprietary solutions.

2 INTRODUCTION

Over the next decade, the way we live, work and use energy, transportation and other city resources and services will progressively change thanks to a range of innovative 'Smart City' solutions. A Smart City integrates physical, digital and human systems to deliver a sustainable, prosperous and inclusive future for its citizens. Many of these innovative solutions will be based on sophisticated information and communication technologies. However, technological complexity, as well as the complexity of the various sectoral services involved within a Smart City, require a system approach to standardisation. Such an approach must promote the greatest possible reuse of existing open standards to accelerate Smart City deployment and exploit the enormous potential deriving from the use of distinct interoperable technologies and from re-use of interoperable applications and services among cities. In an effort to leverage the promise of a system approach, ESPRESSO will focus on the development of a conceptual Smart City Information Framework based on open standards.

3 THEORETICAL FRAMEWORK

The topic of Smart Cities is increasingly discussed in urban planning though there is no sharp definition from a scientific point of view. An embracing explanation is a city, in which „ICT is merged with traditional infrastructures, coordinated and integrated using new digital technologies. These technologies establish the functions of the city and also provide ways in which citizen groups, governments, businesses, and various of agencies who have an interest in generating more efficient and equitable systems can interact in augmenting their understanding of the city and also providing essential engagement in the design and planning process" (Batty et al., 2012, p. 492).

The greatest potential in the use of networked and often centralized ICT solutions in urban areas is thus seen in the context of increased efficiency through innovative technologies (less energy consumption, lower emissions, less CO₂ pollution, etc.). This is often promoted as a contribution for the urban quality of life. In

addition to that, a common and open urban information platform to share the gathered data is also regarded as very promising for companies and citizens – an ideal-typical vision of such a central urban monitoring and simulation system in real-time (Exner, 2015). Due to this, the Smart City topic found its ways on the agendas of big corporations like IBM, Cisco Systems, Siemens, Accenture, Ferrovial and ABB. They are setting their sights on the urban market and are foreseeing a multi-billion dollar market (Ratti & Townsend, 2011, p. 45). It is considered as a big future business field in the ICT-sector for developing tools which could improve the competitiveness and the quality of life for the citizens because. However, „a Smart City is something more than ‘just’ a digital or an intelligent city, where the attention is mainly drawn on the ICT components, as enabling connection and exchange of data and information within an urban environment” (Murgante & Borruso, 2013, p. 630). Smart is an adjective that is currently declined in different acceptation. Smart is the growth expected through the EU2020 strategy, smarts are the communities, the territories and of course the multiple aspects of the urban dimension: the concept of the smart city as next stage in the process of urbanization has been, and it is, quite fashionable in the policy arena in recent and current years. As stated, the smart city concept works as distinct concept from the digital city (referring to connected communities and innovative services) or intelligent city (all intelligent cities are digital cities, but all digital cities are not intelligent) which is shown by Komninos (2002).

Finally, the urban space has become a cross-breed place in which phenomenal experience and virtual experience are combined together to create a socio-technological environment based on the combination of place, networks as well as institutions. Continuous interaction between physical locations and information flows¹ made even more intense by the recent dissemination of geo-referenced applications for cutting-edge devices (Location Based Social Network, Geoblogs...). Shortening drastically, depending on the priority given to the different forms of communication and involvement, we can isolate the following “prototypes” of/for smart cities (Dimitriu & Elisei, 2014):

- The open city: It is the city model that operates with transparency. The communication of its activities is straightforward: decision-making processes in streaming, online publication of all acts, easier access to the file. The adoption of open data model has plenty of space and urban development in this philosophy of government.
- The cloud/platform city: In cities cloud / platform technology becomes a facilitator of the use of the potential of public spaces. Urban space as a software permitting between ideas. A city that °creates an ecosystem that enables both transparency and also economic growth.²
- The creative city: The Creative City, according to Charles Landry (2012), identifies, nurtures, attracts and sustains talent so it is able mobilize ideas, talents and creative organizations. The built environment – the stage and the setting- is crucial for establishing the milieu. A creative milieu is a place that contains the necessary requirements in terms of hard and soft infrastructure to generate a flow of ideas and inventions. A milieu can be a building, a street an area, a city or a region.
- The wiki city: The communication between citizens and institutions is oriented to promote and facilitate the involvement of citizens in the management of the res publica. From the first experiments of e-democracy, in the late 90s, to the recent experience of politics and policies generated through interactions with bloggers. Citizens are called upon to take an active part in decisions that affect the city. Under many aspects Bologna could be considered on the way to be a wiki-city.
- The resilient city: “A Resilient City is one that has developed capacities to help absorb future shocks and stresses to its social, economic, and technical systems and infrastructures so as to still be able to maintain essentially the same functions, structures, systems, and identity.”³ We can even say that a resilient city is the one capable to change its identities and structures in order to assure to its citizens the same or a better level in quality of life.

¹ The Space of flows is a high-level cultural abstraction of space and time, and their dynamic interactions with digital age society. The concept was created by the sociologist and cybernetic culture theoretician Manuel Castells to "reconceptualize new forms of spatial arrangements under the new technological paradigm"; a new type of space that allows distant synchronous, real-time interaction.

² Rachel Sterne, chief digital officer of New York

³ Definition provided by resilientcity.org

International studies from the World Bank (Guasch, Racine, Sánchez, & Diop, 2007) shows that standards can increase productivity and innovation and “will provide the foundation for long term advances in the way software is built, bought and deployed”. The 2011 update on the DIN study on “The Economic Benefits of Standardisation“(Blind, Jungmittag, & Mangelsdorf, 2011) quantifies the contribution of standards to the growth rate, which in each country is equivalent to 0.9% in Germany, 0.8% in France and Australia and 0.3% in the UK. EC studies also found that the two largest factors explaining economic growth are 1) increased stock of capital goods, and 2) availability of a stock of standards. ESPRESSO pursues an integrative approach that understands Smart Cities and Communities as a system of interlinked processes, components, workflows, legal and administrative constraints, or organizational guidelines. Data is provided by many sectoral and heterogeneous systems that need to be made interoperable in order to enable sustainable and economically powerful data integration and processing. ESPRESSO considers open standards as a necessary prerequisite for any such system-oriented approach and reflects all of these aspects in the structure of both its work packages and its consortium. The latter consists of standardisation organizations, private industry (both large integrators and SMEs), cities as final users and customers. The consortium also links to strong user engagements, and research-oriented organizations to ensure embedding of standardisation and reference architecture concepts in applied research studies.

4 PROJECT APPROACH

The proposed ESPRESSO consortium to tackle these issues consists of 16 partners that provide an excellent combination of the necessary competences to achieve the project’s objectives. ESPRESSO has an assembled and interdisciplinary team, consisting of Smart City cities, large scale integrators, governmental owned organizations, SDOs and industry consortia, SME’s, and applied research organizations. Within this group, there is a unique combination of crosscutting skills and experiences suited to the concept of Smart City and Communities and standardisation. In order to ensure social acceptance of developed solutions, ESPRESSO sets up a stakeholder communication network that enables an early dialogue between standards development organizations, technology providers, and technology consumers (cities and citizens as end users) to avoid a mismatch between the design of technology solutions and cities’ and citizens’ needs. ESPRESSO guarantees the inclusion of end-users in terms of planning; design and knowledge transfer along the lifetime of the project. Training material and sustainable platforms will further help to ensure social acceptance in the long run. ESPRESSO includes a dedicated work package to understand the impact of the proposed solutions and technologies, with a specific task focusing on social and organizational aspects. ESPRESSO is based on the assumption that cities will develop and provide a city platform on which most city applications and services will run. This platform will be the main IT backbone that will vertebrate many existing sectoral systems (e.g. energy efficient buildings, smart grid, intelligent transport systems, eHealth systems) and many new applications and systems specifically designed for Smart Cities and running on the city platform. Similar ambitions and efforts to define a Smart City platform have been reported from other parts in the World (such as South Korea or China and some proprietary solutions exist on the market (IBM, Cisco, etc.) (Kitchin, 2014; Ratti & Townsend, 2011).

Standardisation efforts and results are already available in 'vertical' domains like eHealth, Building Energy Management Systems or Building Information Systems, Smart Grid, or Intelligent Transport Systems. These efforts should not be redone or even revised for the case of Smart City, at least at the beginning, but should be analysed and used as they are. What is already available today provides most of what is required. Nevertheless, ESPRESSO acknowledges that in some areas (such as e.g. Internet of Things - IoT) standardisation efforts are on-going and may extend the current standardisation base relevant for Smart City. The horizontal interoperability of applications and services running on top of Smart City platforms is not feasible at this first stage and hence is a long term objective. Horizontal interoperability would result in lots of interoperability dimensions that need to be analysed. Therefore, ESPRESSO avoids crosssectoral standardisation analysis, but takes initiatives such as FIWARE into account that prevent silos and ensure creating bridges towards interoperability between systems that are nowadays defined as silos. The direct involvement of Smart City cities and other relevant stakeholders from on the beginning to ensure reliable and real-world-need-driven development of requirements for open standards for Smart City with the goal to bring as efficiently as possible to the market the greatest number of SCC solutions. It is the aim to integrate business perspectives and relevant means, such as the development of a strategic growth map, which traces a long-term strategy to monitor the effects of standardisation in the Smart City domain, the proposition of a

fast-track standardisation pipeline to increase business and competitiveness, or the development of training material. A further aim is to cross-fertilise and cooperate with on-going actions under topic SCC-1 – 2014/15 and reuse existing networks and alliances to avoid replication of efforts.

- WP 1: Aim is to identify global stakeholders (industry, SDOs, etc.) and geographical clusters in the domain of Smart City (including “lighthouse” initiatives and their potential replicators and Smart City innovation zones) published as an online Interactive Atlas of Smart City and relevant stakeholders. To promote capacity building among the stakeholders in order to create a large ecosystem (called the SmaCStak network), reaching out to hundreds of stakeholders, gathering a community, around ESPRESSO, made of local European and global stakeholders from both public and private sectors. The task will ensure the pooling of stakeholders for later activities (collection of requirement and validation of results), the creation of a large ecosystem on themes relevant for the project among local EC stakeholders, the understanding of the landscape associated to Smart City (incl. regulations and trends at local level) and the facilitation of liaising with relevant international initiatives (standardisation community, international organisations and associations, EC projects).
- WP 2: An additional aim lies in providing a consistent and shared definition of what a Smart City is today in terms of sectoral services and how this may evolve in the medium to long term. This will help select representative use cases, in terms of Smart City standards, for the pilot cities of ESPRESSO, to single out requirements for Smart City standardisation aspects, to define a conceptual standards interoperability framework for Smart City and to map existing standards from various SDOs on top of the conceptual standards framework. Also to carry on a comprehensive SWOT analysis related to future standardisation landscape and to define all aspects related to later interoperability testbeds (e.g., stakeholders to be involved, software modules required or available, different datasets to be harmonized and integrated, hardware or technologies to be supported, specific regulatory requirements, privacy and security requirements) is an aim of the project.
- WP 3: This work package uses the results from WP2 to identify standardisation priorities based on a standardisation criteria matrix and develops in close cooperation with CEN, CENELEC as well as international standardisation organizations fast track recommendations that will be handed over to the corresponding SDOs for future consideration and implementation. In detail, WP3 has the objectives to analyse and document: Overlapping and subsequent harmonization potential of standards across different SDOs, Coordination requirements on new standards or components between European bodies CEN-CENELEC-ETSI, Priorities for standardisation activities within the various SDOs (OGC, ISO, etc.) and development of aligned roadmaps for SDOs and associated organizations, Developments of fast-track guidelines for various SDOs.
- WP 4: Work package 4 has the objectives to satisfy the technical objectives within ESPRESSO, i.e. the development of a shared vocabulary, the definition of reference architecture, the city information and indicator platform, certification program, and execution of pilots. WP4 takes the results from WP2 as its technical baseline and uses results from WP3 that help optimizing WP4 products.
- WP 5: Aim of work package 5 is to identify long-term strategic market implications of standardisation in the Smart City domain brought by technological as well as societal evolution as well as to identify new economic, financial and procurement models which can suit emerging Smart City scenarios and to promote a range of marketing opening actions targeted to standards in the domain of Smart City.
- WP 6: The goal of this work package is to understand and assess the legal, administrative, and societal impacts of Smart City platforms, applications, and workflows enabled by new information technology solutions.
- WP 7: To ensure maximum awareness of the projects activities and achievements through liaisons with other initiatives, through dissemination activities and through web-based publishing initiatives and to organise a wide range of events addressed to a variety of different audiences.
- WP 8: To ensure that all the objectives of the project are met in line with the project schedule and with the highest quality standards, in terms of technical achievements as well as pilot and awareness activities. To deploy a management structure that can ensure the necessary control over the project activities. To ensure monitoring of the project from a technical, operational, financial, administrative point of view.

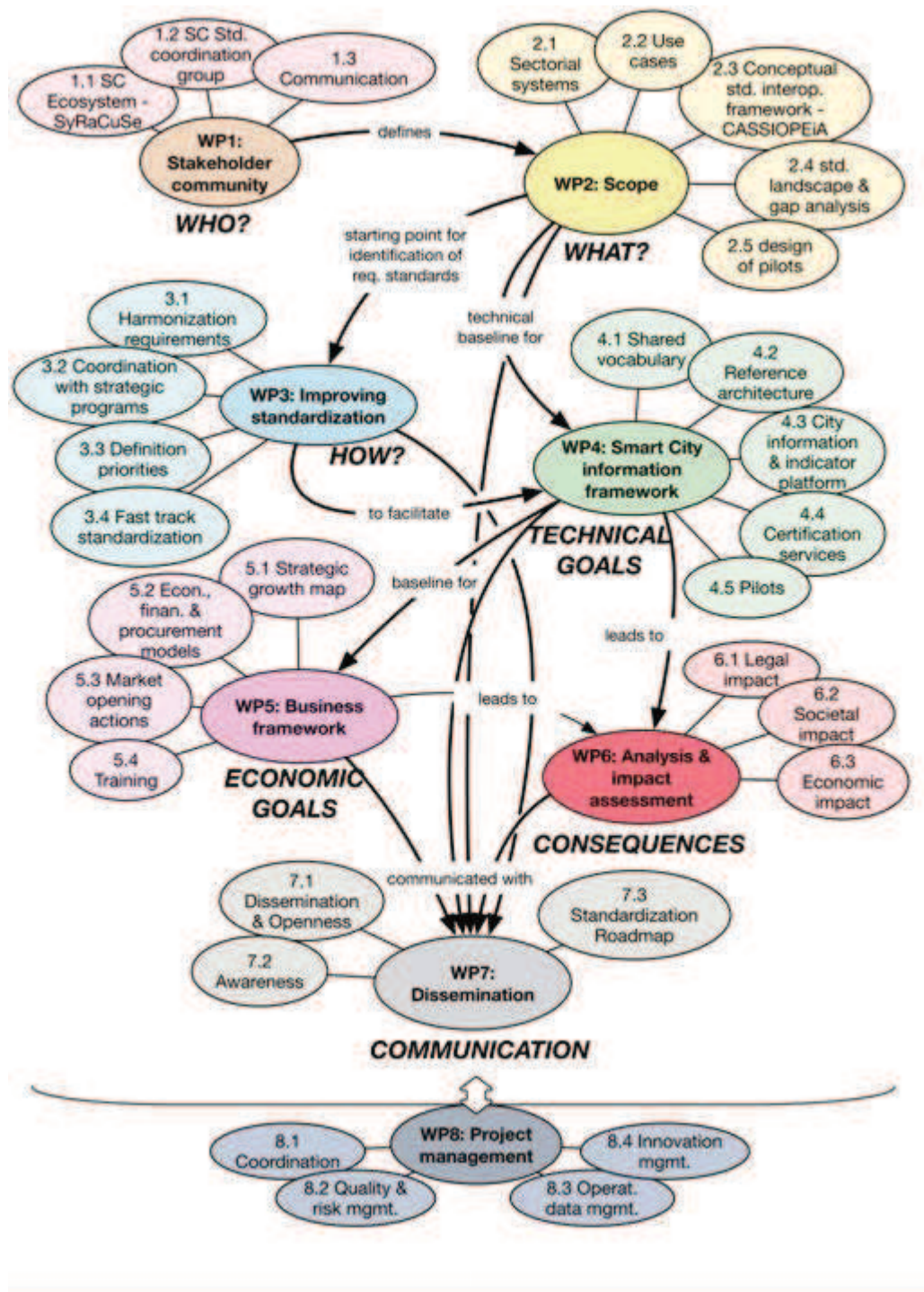


Fig. 1: The ESPRESSO Approach

5 DISCUSSION

Activities carried out within the ESPRESSO framework have the aim to ensure interoperability of Smart City solutions, as well as avoiding entry barriers or vendor lock-in through promoting common meta-data structures and interoperable (open) interfaces instead of proprietary ones. In addition, it is foreseen making relevant data as widely available as possible – including to third parties for the purpose of applications development – whilst using common, transparent measurement and data collection standards to ensure meaningfulness and comparability of performance/outcome measurements.

From a technological perspective, there has to be a specific degree of standardisation in the urban ICT networks. These have to be chosen so that they are not proprietary and prevent innovative Bottom-Up-solutions and equally open to city administrations, companies and citizens. The required interoperability of services implies a certain degree of standardization in urban ICT networks. To build reliable and secure ICT

structures, cooperations with the private sector are necessary. From an institutional point of perspective, the governmental requirements from a streamlining of processes are manifold and enhance potential for implementations of standardisation approaches. These issues will also be tackled with the close cooperation of our urban partners of the project as well as cooperation partners within the Smart City Stakeholder (SmaCStak)-Network. Therefore, it is important that they are not proprietary and prevent innovative bottom-up software solutions. Thus, the democratic legitimacy through full participation is essential in these standardization processes and thus part of a complex planning and city development process (Lojewski & Munziger, 2013). The dependences between Smart Cities, standards and social aspects are far more complex. The potentials of a networked ICT city are important, but also the dangers have to be taken in mind. Especially for public participation, there will be a complex potential, because, “design is a social process and not only a paternalistic process” (Klosterman, 2008, p. 98). The ethical aspects have to take in account that Smart City approaches are not non-transparent "Black boxes" planned in a top-down manner by a small group of "specialists" (Exner, 2014). An important contribution to smarter cities is to foster innovation and creativity in the light of the knowledge-society. This includes also civic bottom-up movements. For example "Civic Hacking" is thereby described as the movement in which united citizens develop their own ICT solutions to urban problems (Townsend, 2013). In the light of these developments, ethical considerations are highly relevant, because “the thoughtful use of smart technologies is a challenge for cities and their future citizens” (Kunzmann, 2014, p. 18). There are many critical considerations regarding Smart City concepts in the scientific discourse (Greenfield, 2013), so these issues also have to be tackled in projects such as ESPRESSO. Most of the well known Smart Cities have concepts, which focus on optimization and efficiency, organized in a top-down manner and regarding the urban area simply as machine, which is controllable and adjustable though the social impacts of Smart Cities and the respective standardization approaches have to be considered and will be part of the work for ESPRESSO, too. In order to ensure social acceptance of developed solutions, ESPRESSO sets up a stakeholder communication network that ensures an early dialogue between standards development organizations, technology providers, and technology consumers (cities and citizens as end users) to avoid a mismatch between the design of technology solutions and cities’ and citizens’ needs. ESPRESSO ensures inclusion of end-users in terms of planning; design and knowledge transfer along the lifetime of the project.

6 CONCLUSION

Smart cities have, above all, a vision – they know what smart services have to be implemented at which point, and they know that through the shared knowledge, increased administrative capacity and the voice of the stakeholders. At the very least, the technology developed has to be understood, valued and integrated in the daily use of the targeted stakeholders, and for this education and capacity-building plays a key role. If it comes to the question if standards could help to empower Smart Cities, this question can be answered with a “yes” from a technological perspective, but this has to be seen in context of the given restrictions. From an institutional and social perspective, the interdependencies are far more complex. One of the most important questions will be, how the Smart City of the future should look like and how to develop a common understanding for these issues. This problem will be tackled by ESPRESSO in order to develop Smart Cities for Europe, which are especially beneficial for its citizens. This embracing understanding of the topic is important, because the transformation towards Smart Cities requires thus a fundamental change in behaviour, both in what concerns the citizens and the local governments. Openness and dissemination activities are essential in order to provide citizens with information on the stakes and benefits of smart solutions, as well as to involve them as future users and even co-designers of smart services – and that is primarily a responsibility of the administration bodies, which need to think in new, integrated long-term policies and citizen-centric initiatives.

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8 LITERATURE

- Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., et al. (2012). Smart cities of the future. *The European Physical Journal Special Topics*, 214(1), 481–518. <http://doi.org/10.1140/epjst/e2012-01703-3>
- Blind, K., Jungmittag, A., & Mangelsdorf, A. (2011). The Economic Benefits of Standardization, 1–24.
- Dimitriu, S., Elisei, P., (2014), Smart cities in the making: the importance of an overarching strategic agendas for Romanian cities. (www.oraseinteligente.ro).
- Exner, J.-P. (2014). Smart Planning & Smart Cities. In P. Zeile, V. Popovich, P. Elisei, & M. Schrenk (Eds.), (pp. 603–610). Presented at the REAL CORP 2015, Wien.
- Exner, J.-P. (2015). Smart Cities – Field of application for Planning Support Systems in the 21st Century? In J. Ferreira & R. Goodspeed (Eds.), (pp. 1–18). Presented at the The 14th International Conference on Computers in Urban Planning and Urban Management (CUPUM), Boston.
- Greenfield, A. (2013). Against the smart city (The city is here to use). New York: Do Projects. Retrieved from http://www.amazon.de/Against-smart-city-here-you-ebook/dp/B00FHQ5DBS/ref=la_B001H6SA1C_1_1?s=books&ie=UTF8&qid=1392878639&sr=1-1
- Guasch, J. L., Racine, J.-L., Sánchez, I., & Diop, M. (2007). Quality Systems and Standards for a Competitive Edge (pp. 1–324). Washington, D.C.
- Kitchin, R. (2014). The real-time city? Big data and smart urbanism. *GeoJournal*, 79(1), 1–14. <http://doi.org/10.1007/s10708-013-9516-8>
- Klosterman, R. (2008). A New Tool for a New Planning: The What if?™ Planning Support System. In *Planning Support Systems for Cities and Regions* (pp. 85–100). Lincoln Inst of Land Policy.
- Komninos N. (2002). *Intelligent cities: innovation, knowledge systems and digital spaces*. London: Spon Press.
- Kunzmann, K. R. (2014). Smart Cities: A New Paradigm of Urban Development. *Crios*, 1/2014, 9–20. <http://doi.org/10.7373/77140>
- Landry, C., Hyams, J. (2012). *The Creative City Index: Measuring the Pulse of the City*. Comedia Publications Limited.
- Lojewski, von, H., & Munziger, T. (2013). Smart Cities und das Leitbild der europäischen Stadt. *Städtetag Aktuell*, 10–11.
- Murgante, B., & Borruso, G. (2013). Cities and Smartness: A Critical Analysis of Opportunities and Risks. In B. Murgante, S. Misra, M. Carlini, C. M. Torre, H.-Q. Nguyen, D. Taniar, et al. (Eds.), (pp. 630–642). Berlin, Heidelberg: Springer Berlin Heidelberg.
- Ratti, C., & Townsend, A. (2011). The social nexus. *Scientific American*, 305(3), 42–6– 48.
- Townsend, A. (2013). *Smart Cities*. New York: W. W. Norton & Company.