Smart Cities – Field of application for Planning Support Systems in the 21st Century?

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Abstract

Starting in the 60s and 70s, the potentials of computer use for scientists and urban planners in the upcoming years with Planning Support Systems (PSS) was considered very promising. After a time of euphoria, the following years had been a disillusionment of this prediction, however starting in the recent years, the circumstances changed dramatically. Cities are full of ubiquitous information technologies and they are understood increasingly as smart and connected urban areas. In order to turn the omnipresence of urban data into benefits for planners and citizens, they could be used within Planning Support Systems (PSS) which help to make the planning process more efficient and to handle complexity better. Whereas the potential for optimizing efficiency seems to be very promising, the rise of new bottom-up-movements in terms of participative and collaborative processes raises new questions for urban planners on their way to develop a transparent decision making and planning process to make cities smarter.

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1. Introduction

The importance of ICT for spatial and urban planners is growing rapidly since the last decades. An increasing ubiquity of geographic information in the city, with its potentials and risks of using for planning purposes is in an intense scientific debate. Due to the increasing penetration of everyday life with sensors and mobile communication devices, networks and data play a crucial role in the concept of an interconnected and intelligent city, the so-called Smart City. This movement "is generating new sources of big data in real time and there is a new sense of optimism about what this can do to cities and their problems" (Batty 2014). Thus, the Smart City finds its way on the agenda of many ICT-companies with respective software solutions. The often used information platforms, could theoretically be a perfect tool, to monitor and control the city and thus to support planning. The bottleneck in terms of data processing in ICT was a problem in the early decades and is not regarded as most important problem in this context any longer. From a scientific point of view, the hopes in an intelligent city lie in the fact, that a contextual urban system can be monitored, analyzed, simulated and also controlled to help planners in their practice. This article aims to deliberate, if an automated city could fulfill the hopes, which were seen in the use of Planning Support Systems (PSS). These are especially issues relating to improving efficiency for saving resources and to handle the complexity of the planning processes and to create plans of higher quality (Geertman & Stillwell 2003).

2. Theoretical Framework

The theoretical framework shows the development towards a ubiquity of urban relevant information, gathered from various sources of sensors or other devices connected via software. These ICT-connections build the framework and basis for the adaption of Smart Cities. In addition to that, the connection between PSS and urban planning will be demonstrated

2.1 Ubiquitous Urban Data

For many scientists, the more than 20-year-old vision of ubiquitous and pervasive computing is becoming reality (Weiser 1991). This is due to the development of smaller and more powerful devices (sensors-devices, cellular phones, tablets etc.), which are interlinked and will be considered as potential data producers and processors. Especially the rapid development of mobile communication devices in recent decades reinforced this trend. Parallel to this, the development of the Internet enables a complete cross-linking of different data sets across platforms from a variety of devices and sources. In this context, the GeoWeb plays a crucial role. Its concept was first described in the 90s and represents a network structure that organizes itself, with a spatial reference linked data and is available over the Internet (Herring 1994; Crooks et al. 2014). By the increasing ubiquity of networked information systems, it is increasingly common for citizens that all units of urban space are connected and interact with each other. Thus the boundaries between sensors, computers and mobile communication devices are disappearing and the computer as a standalone device is no longer perceptible. Therefore, ubiquitous sensors build the foundation for the Internet of Things (IoT), which comes to a greater relevance and corresponds to a vision that Neil Gross postulated over fifteen years with a world, which has an electronic skin full of sensors (Gross 1999).

In this context, User-Generated-Content (UGC) and Volunteered Geographic Information (VGI) were brought in an intensive academic consideration (Goodchild 2007). Also the connection with the human being as integral part of this network will be important. This includes the field of human sensory assessment which aims to detect the human's perceptions in urban areas and to interpret their emotions in the urban context (Exner et al. 2012; Zeile et al. 2014). The utilization of this data and information will be necessary and Big Data methods are seen as the key for this. This approach describes that "big data consists of massive, dynamic, varied, detailed, inter-related, low cost datasets that can be connected and utilized in diverse ways" (Kitchin 2014 p.5).

2.2 Smart Cities

Figure 1: Smart Cities and related terms for urban planners (Own Source)

The concept of Smart Cities is discussed extensively in the recent years especially since the effects of growing ICT-use in everyday life unfold their impact to the society. Smart Cities in the context of urban planning are often connected with a variety of topics associated in the public and academic discourse (Fig. 1). The origins for this discussion are far older. The potentials of integrating a city with ICT were first described in the concept of "Wired City" (Dutton, Blumler, & Kraemer 1987). Parallel to the emergence of the Internet, the connection of network sciences and urban research was also drawn (Castells 2000). Also the "Sentient City" is described in the context of responding ubiquitous sensors in urban areas (Shepard 2011). In summary, there is a large dynamic in the terminology, (see also "Intelligent City" (Komninos 2002) or "Digital City" (Ishida & Isbister 2000)) but in the recent years, the term of "smart city" has been established (Giffinger & Pichler-Milanović 2007; Hollands 2008;. Wolfram 2014).

To define the term of a Smart City from a technological perspective, Batty describes it as a city where ”ICT is merged with traditional infrastructures, coordinated and integrated using new digital technologies" (Batty et al. 2012 p.1). Whereas a lot of discussions focus on the technological aspects, the perspective has to be a lot more wider, because the Smart City is also a place, ”whose economy and governance is being driven by innovation, creativity and entrepreneurship, enacted by smart people” (Kitchin 2014 p.1). Furthermore, it is ”also an inclusive place, using technology and innovative solutions to increase social inclusion and combat poverty and deprivation" (Connected Smart Cities Network 2013). In this context, the Triple-Helix-constellation (cooperation between government, universities and research institutes) is also increasingly understood as an integral part of Smart City in the light of the knowledge society (Komninos 2008; Deakin 2013). The concept of a Smart City must also be seen in the context of the concept of a sustainable city, especially in relation to the concrete implementation in the urban context (Murgante & Borruso 2013). Meanwhile it is increasingly used in the context of European funding policy, having a positive impact on the economy, people, mobility/transport, energy, environment and governance approaches, usually accompanied with corresponding ranking (Giffinger & Pichler-Milanović 2007; Kitchin, Lauriault, & McArdle 2015). As a consequence thereof, the debate if Smart Cities could act as a model for city development is discussed very controversial and offers descriptive, integrative, normative and consensual views (Wolfram 2014).

2.3 Planning Support Systems and Urban Planning

The development of ICT brought new possibilities for urban planners. First simulations of large scale models were made in the 60s (Batty 2008; Lee 1973) for data and simulation and "these models have been focused largely on simulating the location of physical activities, albeit through an economic and demographic lens which enables material transport and the location of land uses to be predicted using computer models of various sorts" (Batty, Axhausen, Giannotti, et al. 2012 p.18). PSS have a close relation to large scale models. They are geo-information-technology-based tools, that support planners in achieving their specific tasks (Geertman & Stillwell 2003; Batty 2008; Klosterman 2008). Whereas PSS in the late 80s was considered in the beginning as a loose assemblage of computer based tools (Batty 2008), the linking to GIS was increasingly seen later (Harris 1989), especially for urban planners (Geertman 2008). In addition to that, the relevance of Spatial Decision Support Systems (SDSS) for urban planning was also growing (Timmermans 2008). Though, these systems have to be seen from a short-term perspective. Whereas DSS focuses more on operational decision making, PSS have to be understood as more strategic (Geertman, Toppen, & Stillwell 2013). In addition to that, a new generation of agent-based models as well as cellular automates made an appearance since the beginning of the nineties (Batty 2014).

For urban planners, the use of PSS from a scientific point of view is predominantly connected with two factors: efficiency (saving time and resources) and the handling of complexity of the planning process (Geertman et al. 2013). Especially the second aspect has to be seen critically, because the ideal-typical imagination that everything can be simulated turned out to be wrong and the growing influence of public participation as a rather unorganized process is thus hard to integrate in systematic models like PSS. These aspects have to be deliberated in the same way in the context of smart cities. In general, it has to be stated, that ”after the first waves of enthusiasm and the inevitable reaction against many overhyped claims for what might be done, the field begins to settle and consolidate and adapt to the routine and rigours of practice” (Batty 2014, p.389).

3. Practical Framework

Based on the terminology and influencing factors for Smart Cities, the following section provides more detailed information about the characteristics. The question about the use-potential of a PSS for planners has to be seen as previously mentioned in the points of improving the planning process in the light of efficiency and to handle complexity. In this context, a technologically deterministic approach is focusing on questions on how to save resources whereas issues relating complexity are mostly dealing with institutional and societal aspects. These aspects embrace for example the reduction of carbon emissions to improve the urban environment as well as the design of new tools for participation in the planning process.

3.1 Technology and efficiency

Smart Cities regarded from a technological-deterministic view produce a lot of data and require the use of powerful geographic information systems to analyze this data. 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 CO_2 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 is for example the Rio de Janeiro's "Operation Center" developed by IBM, in which each element of the city can be monitored via computer screens in a NASA-like control center (Fig. 2). An example for a platform-based approach is the project "LIVE Singapore!" (Kloeckl 2013), in which the MIT SENSEable City Lab in cooperation with local partners develops a platform for urban real-time data in the city-state of Singapore. This aims to be open in the future for all interested citizens and companies, but can also act as a direct real-time control tool for the mayor, to support him in terms of planning and governing. Comparable projects can be seen on the agendas of any large ICT-companies such as IBM, Cisco Systems, Siemens and Microsoft. These postulated Smart City-models will of course correlate with their own respective corporate business goals.

Figure 2: Rio Operations Center (Cidade Olimpica Rio de Janeiro 2013)

Technologically deterministic approaches are often organized in a top-down manner and come with comprehensive investments in infrastructure. These top-down concepts are often developed in cooperation with ICT-companies or research institution. Due to the close cooperation with companies in the ICT sector, the cities often serve as an example model and thus as a marketing tool for the companies. Well-known examples of this type are Masdar in the United Arab Emirates and New Songdo City in South Korea. These two examples are designed completely new from the ground up on open space and thus have similarities with the way of planning "ideal cities" at the beginning of the 20th century like Brasilia for example. In these cities, the role of citizens is often limited as a recipient of data and service. However, the understanding of the city as plannable system with a "serene and masterful guidance of the city-as-machine-for-living we hear from Siemens or Cisco or IBM are strikingly reminiscent of Le Corbusier" (Greenfield 2013 pos.1273) and it is considered very critically in retrospect from an urban planning perspective.

3.2 Institutional aspects

City councils were increasingly discovering the topic of Smart Cities and try to combine it with their development perspectives. Often, they aim to pretend to be as smart as possible for marketing purposes. Corresponding programs focus on efficiency aspects and aim to raise the awareness for the topic as well as to steer some projects relating to the topics of Smart Cities. Such examples for Smart Cities are Vienna (smartcity.wien.at), Amsterdam (amsterdamsmartcity.com) or London (www.london. gov.uk/priorities/business-economy/vision-and-strategy/smart-london).
Websites act as a central hub for information and communication, which represents the strategic and operational goals of the city council and portray specific projects. For citizens, these websites mostly offer information in a passive way, but active participation through these platforms to enrich the planning process is often not foreseen. In this context, the scientific recommendations often suggest the inclusion of innovation models (Komninos 2008; Allwinkle & Cruickshank 2011; Deakin 2013). This leads to a stronger focus on the triple helix constellation and the collective learning process including the formation of networks to exchange experiences with other cities (Campbell 2012). The measures have to be taken in the context of human capital, education and economic development (Kitchin 2014) as well as for governance and participatory approaches (Caragliu, del Bo, & Nijkamp 2009).

To implement Smart Cities in the urban landscape, standardizations and certifications are often regarded as essential part to steer this development. The question will be discussed, with which approach standards could help to improve efficiency. Activities in standardization from respective agencies (e.g. CEN/CENELEC, ISO/IEC and DIN) which should foster interoperability between different Smart City systems and which are in a strategic important position in the perspective of economic effects through their strong influence on national standards will be more important in the future (VDE 2014). The required interoperability of services implies a certain degree of standardization in urban ICT networks. To build reliable and secure ICT structures, cooperation with private sector are necessary. Here, cities will need to decide whether to take the convenient choice of a single vendor with respective conditions, or whether they rely on diversified and therefore more expensive solutions (Wolfram 2014). What cities require, according to Townsend, is "a robust infrastructure that is centrally planned, safe, efficient and reliable at a reasonable cost" (Townsend 2013 p.154). If standardization will be an integral part in the constitution of Smart Cities, the respective influence concerning scientific foundations or also economic interests has to be identified. 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 process (Lojewski & Muniziger 2013).

3.3 Societal aspects

A further potential for a city to be "smart" is seen in the bottom-up approach and participatory efforts. As mentioned previously, citizens can produce data, which can be used for efficiency purposes, but this does not embrace the whole social potential. A focus on the social component via the inductive and innovative potential of the population can help to achieve creative solutions to urban problems. Due to the increasing use of ICT in the daily life and developments such as social networks, the citizens have the opportunity to act on their own responsibility and to participate as active citizens in their city. Streich sees in this context that ”the processes of urban acting has to be seen in the light of the changing social and technological framework” (2014 p.110). It is important, to connect the creative engagement of citizens with urban problems. A basic infrastructure in the sense of an open platform can act as a "tool box" in order to work actively within their abilities. This can happen as part of a diverse citizen-centric service offering, as well as a platform on the basis of institution or organization. Such an approach is to be seen in the project “LIVE Singapore!” (Kloeckl 2013). Here the public administration wants to foster creative solutions by providing a wide array of urban data to the citizens.

Besides the data-focused approaches, another concept is knowledge sharing platforms. An example is the website "City Mart" (citymart.com) on which various software solutions to handle different urban problems are collected. People can browse this platform in order to detect comparable problems and to adapt solutions to their own urban problems. In this context, smartphone apps are often considered as a viable mobile tool to allow citizens an easy access to urban data, knowledge and services. As an example of the design of innovative approaches smartphone apps can be used competitions like "NYC Big Apps" (nycbigapps.com), from which a wide range of services such as car park and bicycle paths navigation systems emerged. An exclusive focus on providing individual applications for mobile communication devices can thereby miss a holistic approach - but they may be considered a first step on the experimental field to understand the city also as an “urban laboratory”.

4. PSS and Smart Cities

The expectations of connecting PSS and Smart cities are in some points very promising. The following chapter shows the linkage in relating points such as improving efficiency in smart cities and handling the complexity of planning relevant processes in the correlation to smart cities, especially regarding the prospects in terms of PSS. Based on this complex relationship, the concluding part shows the requirements for urban planners working in this field.

4.1 Improving efficiency

Improving the efficiency in the planning process may also help in improving the efficiency of the whole urban system. The more the city turns into a highly complex and networked ICT-space to improve efficiency, the more requirements need to be fulfilled for a smooth technical interaction. Though, the dangers are factors of instability. This applies both to internal factors such as system instability and external influences such as hackers. In this case, the urgent need is seen, to transmit a sense of security to the citizens (Townsend 2013). The more an ICT-centric a city is, the greater the vulnerability of this system (Greenfield 2013; Townsend 2013; Kitchin 2014). A complex, intermodal and automated communication system for mobility for example must be a resilient structure, particularly with regard to internal system errors and external influences (e.g. cyber attacks). Even a small software malfunction in the meshing digital infrastructures could lead to huge implications (congestion, accidents, etc.). Urban actors need to be aware of where the border for blind trust is to be taken into algorithms and mechanisms which control these routines. A technocratic and data-focused urban policy conveys an impression of solidity, practicality and efficiency. Though, the circumstances under which such approaches were based are besides scientifically reasons dependent on a ”system of thought, technical know-how, public and political opinion, ethical considerations, the regulatory environment, and funding and resourcing” (Kitchin 2014 p.9).

Furthermore, there is also the risk of a dependence on the providers of ICT infrastructure, because the efficiency of thought is inextricably linked with corresponding control functions. Corporations see their vision of a "city operating system", which is developed once and then adapted to the various cities. It simply needs to be updated. This strong influence of the private sector and the danger of vendor lock-ins has already being discussed intensively for several years (Hollands 2008). Though, a unilateral criticism of the concentration of urban services at ICT companies is not purposeful, because a ”centralization of Smart City infrastructure is risky, but decentralization doesn’t always increase resilience” (Townsend 2013 p.265). In this case, the dilemma arises between the business-oriented views of large corporations and their standardized products to maximize profits and the need for a tailored solution for each unique city.

By using UGC-data, valuable information can be produced (such as crowd sensing-based traffic measurements) in order to reveal previously unseen urban patterns and to improve the understanding for cities – and thus to “improve” the urban system in terms of efficiency. Though, these sensing methods in the planning practice have always been considered very critically, because it is only a small step to violations of the privacy (Exner 2013). Furthermore, the analysis of social media data for example is very young field of research, especially with the use for urban planners. Observations are often based only on a specific user community, publicly available data is not always a reflection of the general opinion of groups and the design of user interfaces affects the behavior of the users for example (Ruths & Pfeffer 2014).

This leads to the question, what role citizens can take - and especially want in a fully automated and controlled urban system. It will be important for the citizens to see their benefits in terms of energy savings for example, but on the other hand, that the city is more than a system, which can be simulated. The ethical aspects must be taken into consideration so that Smart City-platforms are not opaque black boxes whose operation is only understood by a group of specialist (Townsend 2013). Due to the dynamic changes and developments in technology it is clear that the topics of Urban and Regional Planning, ICT and Geoinformatics as well as IoT and Big Data cannot be viewed in isolation, especially in relation to the associated risks (Townsend, 2013; Greenfield, 2013). Thus comes the risk that ”these technologies are invisible and hence (…) in command rather than in dialogue with users" (Sassen 2011). Another problematic issue is that questions concerning the legal liability for defective automation routines of urban processes are in the future. Who is responsible for ineffective routines or even worse, for injuries in an automated traffic system? A discussion on this issue from a legal-academic point of view will be very urgent in the future.

4.2 Handling complexity of planning processes

To reduce the complexity of the planning process in the light of Smart Cities, it has to be seen in a twofold perspective. On one hand, various software-tools help planners, to make analyzing and designing for example a lot easier and transparent. This could be in the way of workflowmanagement systems as well as generic 3D-city models. On the other hand, new forms of urban data, especially UGC and bottom-up-approaches enrich, but also complicate planning processes. If citizens won't be reduced on a passive role of a recipient of urban services, they will be actively involved in Open Government movements for example. As previously mentioned, urban information platforms can flexibly deploy municipal or government information services to the population. These software platforms can serve as the foundation of similar "app stores" to offer services (by citizens or public authorities), which can be fitted to every kind of urban problem. An intelligent combination with existing solutions for urban problems can be very useful. To be successful, such platforms must be as easily accessible, user-friendly and in relation to the data structure modular and flexible (Townsend 2013). Though, Batty also noted in his work on "The New Science of Cities", that despite all the potential in the context modeling and simulation, the difference between reality and model should not be ignored (2013). A 100 years ago, it was determined, that the city is to be regarded more as an organism than as a machine (Geddes 1915).

Urban development processes must be understood holistically so that the population is encouraged to participate. The mantra of Jane Jacobs "Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody" (Jacobs 1961 p.238) is even more important in the context of Smart Cities (Greenfield 2011; Townsend 2013). 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 this context, it can be referred to organizations such as "Code for America" (codeforamerica.org) and "Code for Germany" (codefor.de). Top-down-Governance approaches are often aligned to strong technocratic and by a marked-oriented approach with neoliberal ethos, but important aspects for the citizens such as quality of life are only marginally considered (Kitchin 2014).

4.3 Required qualification for urban planners

The aspects previously described outline the interdisciplinary nature in the field of urban planning, urban development and geoinformatics. Planners must act as experts on urban information in evidence to evaluate the respective accuracy, versatility and resilience in a way as ”notaries and lawyers of knowledge” (Streich 2014). Just with this knowledge, PSS could be used to bring benefits to the citizens and not only the planning process. Therefore actors in urban planning fields (city planners, geoscientists, architects, mayors, etc.) must be aware of this complex relationship and must have experience in these thematic fields. This includes knowledge in the context of ICT and geoinformatics as well as organizing governance approaches and the understanding of social issues. Therefore, an intensive discourse with respect to developing integrated urban development concepts is necessary and expertise in terms of mediation and moderation is essential, especially while handling complex planning processes.

If the use of urban information and knowledge platforms in Smart Cities as part of PSS will be fostered for an exchange of expertise between citizens, businesses and institutions, such knowledge is also required for planners. The challenge is to combine the best forms of top-down and bottom-up approaches. To ensure this, these platforms should ensure reliability and flexibility for the involvement of many actors. 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). As interdisciplinary experts, it is also work of the planners to include groups in planning processes, which are not that skilled in participating via new ICT-tools in urban planning issues. For those groups with limited capacity for political articulation, there is a risk of social exclusion which has to be avoided. The vast majority of Smart City concepts nowadays focuses on optimization and efficiency and considers cities a machine that is easy adjustable and configurable. Therefore, the planners approach to use software to support the planning process should not be considered solely from technocratic perspective. The approach has to be more holistic also to take the social values of the citizens into account. In order to work successfully in future in this working field and to act as an interdisciplinary mediator of diverse interests, planners in smart cities of the future have to be "at least as familiar with the work of Jane Jacobs, Jan Gehl and Holly Whyte as they are with that of Vint Cerf or Eric Raymond" (Greenfield, 2011).

The technological development brings a lot of potentials, but it will also be hard to match all expectations of the promising adaption of PSS. It has to be considered as a crucial point as well, that every city is unique and hence it will be complicated to create an all embracing blueprint for an urban PSS or a Smart City. A concept will just be sustainable, if the system is tailored to fit the city, and not if the city is just oriented on technological aspects. From an urban planning perspective, it is important to integrate also social aspects to the consideration and to avoid an exclusively technocratic view. A strong technocratic influence to urban planning theories and its consequences (Le Corbusier understanding of a house or a city as machine to live in or the car-friendly city just as examples) should be a warning example in that case. It is also important to take a look back in the scientific history, because “there is often an assumption that all that has gone before is now irrelevant - including PSS - and that computer science, data mining, and new forms of artificial intelligence will provide the answer” (Batty 2014 p.390).

5. Conclusion

This paper elaborates if PSS could be understood as an essential part of Smart Cites. The two most important hopes lie in terms of efficiency and handling the complexity of the planning process as stated previously (Geertman et al. 2013). In terms of improving efficiency and saving time and resources, the potential is enormous. To handle the complexity of planning processes this issue is very ambiguous. From a technical point of view, the answer would be yes, but from the social perspective with the new emergence of bottom-up-planning-movements, a different picture is shown. Efficiency is often seen as key to sustainability, but the so called “wicked problems” (very complex planning tasks where problem and solution is not well defined) in urban planning will induce some difficulties (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 is a need for a “vibrant debate about the limits of smart cities, and the extent to which a new science can be fashioned to support the planning of the most complex systems we have - cities” (Batty 2014 p.4). So whatever the path for Smart Cities or PSS might be in the future, they have to be open, transparent and accompanied with ethical considerations. Not only city, systems and planning processes have to be smart - the citizens have to be in focus of the consideration.

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