

# Smart City trends and ambitions

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## Abstract

Research into smart city projects and applications has been increasing in recent years (Meijer & Bolivar, 2015). The smart city concept is mostly considered from a technology-oriented perspective that stresses the usage of data technologies, big data and ICT to 'smarten up' cities. In contrast, attention to soft aspects of the smart city – i.e. smart governance, smart people and social learning – seems to be limited both in academia and in practice. Moreover, what seems to be largely missing in the literature is empirical insight into the extent to which different smart city aspects are factually known of and applied in different geographical contexts. The aim of this contribution is to make a contextual comparison of smart city applications based on a mainly quantitative empirical analysis. Therein, in particular emphasis will be put on the knowledge government practitioners in the Netherlands have of smart aspects and to what extent they are willing and able to implement smart aspects in their specific local and regional contexts. The results show that both in the Netherlands and worldwide there are huge ambitions to develop and implement smart city applications, but that to some extent factual activities are lagging behind. Reasons for this mostly relate to lack of awareness of the possibilities and lack of financial and political priority. This is especially true for the smaller-sized cities in the Netherlands. When this will be resolved, actual activities are more likely to live up to the huge ambitions regarding the smart city concept.

*Keywords:* Smart City; Smart Governance; State-of-the-art

## 1 Introduction

Smart city initiatives continue to be implemented worldwide. Over the past years a wide variety of smart city ambitions and accomplished projects have been implemented, either in the form of complete smart cities or by means of individual smart projects. Examples of the first form can be found for instance in China, where firms like IBM and Siemens have been involved in the setup of several hundreds of complete smart cities, such as Songdu. Examples of the last form can be found in many other instances such as Barcelona (Barcelona Digital City, 2016), which has its own overall smart city framework that constitutes of smaller projects, or Amsterdam's smart city platform (Amsterdam Smart City, 2016) that constitutes a variety of smaller smart city projects and initiatives. However, even though in practice there seems to be a lot happening in terms of smart city projects and applications, academic research into smart city projects, applications and the concept itself still has been relatively scarce, although increasing in recent years (see e.g. Meijer & Bolivar, 2015). Furthermore, research into smart city developments has been limited foremost to conceptual research or to the empirical investigation of individual projects. What is lacking at the moment is empirical research that provides a more state-of-the-art overview of smart city developments. One of the very

few examples of these is provided by Neirotti et al. (2014) who show an empirically based worldwide overview of the geographic distribution of smart city developments. In addition to this worldwide overview we intend to provide a more detailed but still empirically based overview of smart city developments in the Netherlands. Therein, we intend to provide some additional background insights too. As such, in comparison to the Neirotti et al. (2014) paper this article provides on the one hand a more detailed overview for a specific area, the Netherlands; and on the other hand it provides a more detailed insight into the background of differences with respect to smart city developments.

The article is structured as follows. The next section gives an extensive overview of existing literature about the smart city and its applications. First, special consideration is given to the smart city domains as identified by Giffinger et al. (2007) to be able to differentiate the smart city concept. Thereafter, we shed light on the outcomes of a worldwide smart city empirical research to see how the concept is geographically differentiated (i.e. based on Neirotti et al. 2014). In addition, we will elaborate on our empirical research in the Netherlands on the ambitions with smart city aspects. Subsequently, these results are confronted with the outcomes of Neirotti et al. (2014). This contrast is used as a basis for an overall discussion and conclusion based on both the literature and the empirical results.

## 2 Smart city - a fuzzy concept

Smart city is a very timely and contemporary concept that seems to become increasingly important for different stakeholder groups, such as businesses, governments and the wider public or civil society. There are many different descriptions and definitions of the smart city concept (e.g., see Fernandez-Anez 2016). There is no universal consensus on its meaning and therefore it can be envisioned as a fuzzy concept (see e.g. Batty et al., 2012; Caragliu et al., 2011; Lombardi et al. 2012; Papa et al., 2013). However, for the sake of clarity and despite its fuzziness, in this chapter we attune to the smart city definition given by Caragliu et al. (2011) "...when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance."

To shed more light on this fuzzy concept we conform to Giffinger et al. (2007) who conceptualized the smart city in a report for the European Union into six domains: governance, economy, living, environment, people and mobility (see Figure 1). For a theoretical elaboration on these smart city domains, please refer to Giffinger et al. (2007).

Figure 1: Characteristics and Factors of Smart City (Giffinger et al. 2007)

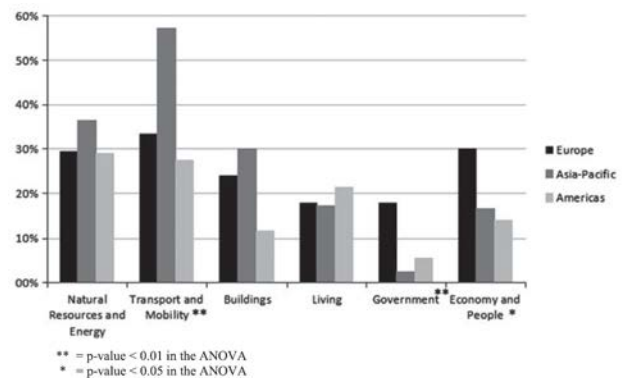
<b>SMART ECONOMY</b> (Competitiveness)	<b>SMART PEOPLE</b> (Social and Human Capital)
<ul style="list-style-type: none"> <li>▪ Innovative spirit</li> <li>▪ Entrepreneurship</li> <li>▪ Economic image &amp; trademarks</li> <li>▪ Productivity</li> <li>▪ Flexibility of labour market</li> <li>▪ International embeddedness</li> <li>▪ Ability to transform</li> </ul>	<ul style="list-style-type: none"> <li>▪ Level of qualification</li> <li>▪ Affinity to life long learning</li> <li>▪ Social and ethnic plurality</li> <li>▪ Flexibility</li> <li>▪ Creativity</li> <li>▪ Cosmopolitanism/Open-mindedness</li> <li>▪ Participation in public life</li> </ul>
<b>SMART GOVERNANCE</b> (Participation)	<b>SMART MOBILITY</b> (Transport and ICT)
<ul style="list-style-type: none"> <li>▪ Participation in decision-making</li> <li>▪ Public and social services</li> <li>▪ Transparent governance</li> <li>▪ Political strategies &amp; perspectives</li> </ul>	<ul style="list-style-type: none"> <li>▪ Local accessibility</li> <li>▪ (Inter-)national accessibility</li> <li>▪ Availability of ICT-infrastructure</li> <li>▪ Sustainable, innovative and safe transport systems</li> </ul>
<b>SMART ENVIRONMENT</b> (Natural resources)	<b>SMART LIVING</b> (Quality of life)
<ul style="list-style-type: none"> <li>▪ Attractivity of natural conditions</li> <li>▪ Pollution</li> <li>▪ Environmental protection</li> <li>▪ Sustainable resource management</li> </ul>	<ul style="list-style-type: none"> <li>▪ Cultural facilities</li> <li>▪ Health conditions</li> <li>▪ Individual safety</li> <li>▪ Housing quality</li> <li>▪ Education facilities</li> <li>▪ Touristic attractivity</li> <li>▪ Social cohesion</li> </ul>

## 3 Smart City domains: empirical evidence at the global scale

Looking from an empirical perspective to these six smart city domains it appears that there is hardly any empirical data that

provides insight into the application of these domains. Neirotti et al. (2014), as one of the few identified, empirically researched current trends in smart city initiatives worldwide, with close resemblance to the domains of Giffinger et al. (2007). They conducted an empirical analysis on a sample of 70 cities worldwide that have claimed to have developed projects and best practices in one or more of the smart city domains (see Figure 2).

Figure 2: Smart City development trends per region worldwide (Neirotti et al. 2014)



Although the categories in the research by Neirotti et al. (2014) just partly overlap to the Giffinger et al. (2007) domains, a clear general picture can be distilled from this. First it shows in general some similarity in focus on Natural Resources and Energy, Transport and Mobility, and on Buildings. The other categories of Living, Government, and Economy and People show less attention. Besides this general picture there exist some significant differences across continents, in particular for Transport and Mobility, Government, and Economy and People. Asian cities have paid particular attention to the Transport and Mobility domain, whereas less to Government and Economy and People domains. The European cities pay much more attention to Government than the other continents. Both North and South American cities exhibit less smart city initiatives than their European and Asian counterparts.

Furthermore, in the study of Neirotti et al. (2014) it is stressed that the number of domains covered by smart city initiatives seems not to be correlated to the size of the city. This implies that both large and small cities are capable of showing innovation with regard to smart city implementation. This reinforces the need for more empirical scrutiny of the smart city concept in various geographical contexts and at different scale levels. Building on this, we are especially interested in how these results translate to a more detailed context like the one of the Netherlands. In the next section we will elaborate on the methodology applied and the results of this study.

## 4 Smart City in the Netherlands

Using the conceptual study by Giffinger et al. (2007) and the empirical study by Neirotti et al. (2014) as a reference point it becomes interesting to look in more detail at the spread of smart city developments in one specific country, in this case the Netherlands. This is of interest given the fact that the

Netherlands is a relatively densely populated country consisting of a variety of different-sized cities, and possessing a high degree of internet coverage.

The empirical data used for this article is based on an empirical research project carried out in a joint project between Utrecht University and Vicrea Solutions, a Dutch geo-IT company. In this explorative empirical research the focus was on getting an overview of and deeper insight into the smart city knowledge of government practitioners and the implementation of smart city applications in Dutch municipalities. For that, the research project used a mix of qualitative and quantitative research methods, with a broad approach at the beginning and a more detailed approach later on in the research.

The quantitative data collection consisted of a survey to gather empirical data about smart city aspects and their implementation in Dutch municipalities. The survey questions were derived from an extensive literature review (as summarised briefly in the previous section). Therein a focus was laid on the six smart city domains of Giffinger et al. (2007). Questions were asked related to the municipalities' current implementations of smart city initiatives and to their future smart city ambitions. The questionnaires were filled in by 131 employees from 94 municipalities, which is about a quarter of all Dutch municipalities. The quantitative data were analysed in detail with the use of SPSS statistics software.

The qualitative part of the research consisted of in-depth interviews with stakeholders at six municipalities and two private companies. These semi-structured interviews focused on the knowledge that municipalities had of smart city and explored whether there were practical examples of smart city applications in that municipality. The different smart city domains as discussed in the theoretical section were also discussed in-depth using a topic list. However, the interviews mostly served as an open discussion platform to make sure that the interviewees could express their knowledge and ideas about the smart city concept. In the Netherlands, municipalities are seen as important actors that can stimulate and facilitate smart city initiatives. Interviews were conducted with four large municipalities (>50,000 inhabitants), one middle-sized one (20,001-50,000 inhabitants) and one small one (<20,000 inhabitants), according to the sizes that CBS Statistics Netherlands suggests (CBS, 2015). The interviews were transcribed, summarized and analysed. This analysis was used to support the interpretation of the quantitative data.

Since smart city can be seen as a 'fuzzy concept', both the interviews and the survey started off with a brief explanation of the smart city concept based on academic literature. Furthermore, the survey was long and relatively complex because of its specific content, especially for some employees who might not have worked with the smart city before. As a result, not all respondents were able to finish the complete survey, so N-value varies per question. Still, the results of a quarter of all Dutch municipalities in 2016 represent an interesting and informative overview of the state-of-the-art of smart city applications in the Netherlands, which will be outlined in the next section.

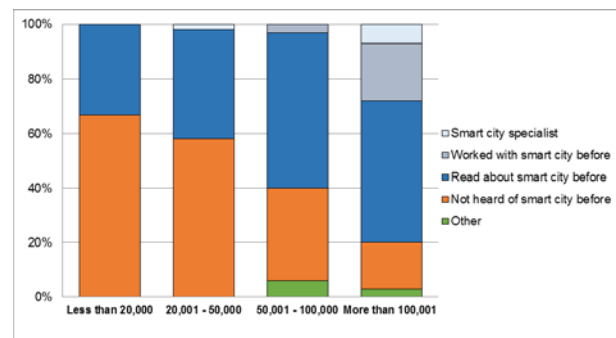
## 5 Smart city domains in Dutch municipalities: unknown is unloved?

This section describes the most important results of the empirical research in the Dutch context. Quantitative data is analyzed with the use of graphs, whereas qualitative data serves as a support or explanation to the numerical data.

### Smart city awareness

With regard to awareness, quite remarkably, almost half of the respondents of the survey had never heard of the smart city concept before and just very few respondents have already worked with smart city applications or consider themselves as specialists in this field (Figure 3).

Figure 3: Smart city awareness divided by population size of municipalities (n = 131) (Wijs, 2015)



The respondents who answered 'other' can be classified as smart city experts or respondents that had read about smart city before. When looking at municipal sizes, respondents in smaller municipalities were less often aware of the smart city concept in comparison to respondents from larger municipalities. At first sight this seems to counteract the evidence of Neirotti et al. (2014), who found that size or density is not necessarily correlated with the implementation of smart city aspects. The remarkable lack of awareness in the smallest categories leads to the suggestion that the size of cities or municipalities still needs to exceed a threshold level before awareness starts to significantly increase, but this needs to be further tested.

Figure 4: Word cloud of most used words to describe 'smart city' (Wijs, 2015, author's own translation)



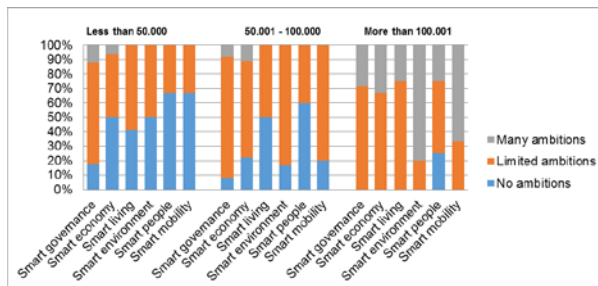
Because of the fuzziness of the smart city concept, the survey asked respondents to name a maximum of three characteristics of the smart city concept. Figure 4 presents the most used terms to describe the concept as the biggest. The results suggest that most respondents think smart city is among other things about data, digital infrastructure, ICT, the city and, for example, environment and efficiency. From the qualitative analysis, a similar result was found. The associations respondents expressed concerning the smart city concept were much in line with the academic literature about the concept, which also has a predominant orientation towards ICT-related aspects. Still, when looking at the variety of academic literature and the amount of smart city projects, it could have been expected that more respondents would have been familiar with the smart city concept.

*The (ambitions for) application of smart city concepts*

The use of smart city applications is still in its early stage for a lot of Dutch municipalities. Respondents mostly rate their application of the smart city concept as just sufficient or even insufficient. Interviewees mentioned that the application of smart technologies could be improved and that projects are just starting up. The importance of experimenting was addressed in the qualitative research. Experimenting, for instance through urban living labs, could help municipalities in finding the most suitable smart applications for them.

Due to the restricted amount of factual smart city applications in Dutch municipalities it was not possible to compare directly the outcomes of the worldwide research by Neirotti et al. (2014) with our own results (Wijs 2015). Instead, we took the differential ambitions on the identified smart city domains by the Dutch municipalities to reflect their expected applications of the smart city concept (see Figure 5).

Figure 5: Degree of ambitions on smart city divided by population size of cities (n=36) (Wijs, 2015)



As stated before, in general the larger Dutch cities express more explicit smart city ambitions than the smaller towns. When divided along the domains by Giffinger et al. (2007) the smart governance aspects in Dutch municipalities seem to be more advanced than in the worldwide smart city applications according to the work of Neirotti et al. (2014). This could possibly be explained by the relatively open and participatory nature of Dutch planning processes. When looking at the domains of smart people and smart living, there certainly are ambitions, for example for improving social cohesion; although identical to Neirotti et al. (2014) these ambitions are still restricted. Furthermore, these ambitions seem to be not

very explicit and the use of data and technology within these domains seems to be rather limited. About two-thirds of the respondents indicate that these ambitions for smart living are restricted by certain frictions such as lack of political priority and lack of finances. In addition, more than half of the respondents feel that privacy issues could have a restricting role when it comes to smart people applications, whereas a small group of respondents state that privacy issues will likely decrease over time. Smart economy seems to take a middle position in the smart city domains, both in the Dutch ambitions (Wijs 2015) and in the worldwide smart city applications according to Neirotti et al (2014). Municipalities stated that there are ambitions for smart economy, especially because there is a demand from citizens and businesses to expand on this and because private actors can get started with this domain. Smart environment seems to be a domain with a lot of ambitions, which can be read from the outcomes of the worldwide survey by Neirotti et al. (2014) too. Respondents state that sustainability is always incorporated in policy and smart city projects, although according to Dutch respondents the link between this domain and ICT seems limited. Finally, the domain of smart mobility could be seen as a transboundary domain that goes beyond municipal jurisdictions. Ambitions for smart mobility are quite substantial, likewise to those for environment. These conclusions seem in accordance with those found in Neirotti et al. (2014). Overall it seems that ambitions around the environment and mobility correspond to the smart city applications worldwide according to Neirotti et al. (2014).

**6 Conclusion and discussion**

This article has focused on the current and widespread attention to smart city projects and applications. Although a dominant worldwide model for implementing the smart city seems a bridge too far, in this relative early stage of development it is interesting to see in what sense the different domains of smart city find their application in reality. Up till now, empirical research on smart city implementation is however very much restricted. Therefore, we executed empirical research in the Netherlands and compared its outcomes to the only other quantitative empirical study on smart city applications we are currently aware of (Neirotti et al. 2014). In that, we hope to shed more light on the priorities in the implementation and application of smart city domains and in the geographical commonalities and differences.

One of the most striking findings is that especially in the smaller-sized Dutch cities and municipalities the majority of the respondents have never heard about the smart city concept, indicating only a limited awareness of the concept in Dutch policy practice. This is somewhat unexpected, given the widespread attention to smart city concept in academia, business and public administration in many parts of the world (cf. Neirotti et al., 2014). Also, this seems to contradict with their earlier findings that city size or density is largely uncorrelated with the possibility to implement smart city innovations. Our data suggest that a certain threshold in terms of city size population is still needed to significantly increase the awareness and implementation of smart city ideas.

Next to this, we found some interesting and important similarities and differences between our data concerning Dutch municipalities and the earlier worldwide empirical work of Neirotti et al. (2014). Similar to their findings, also in the Netherlands overall we found clear ambitions to develop and implement smart city applications, at least within the bigger cities. However, implementation of in particular the governance-related smart city applications seem to lag behind from what we would expect. Reasons for this mostly relate to lack of awareness, lack of political and financial prioritization and data security issues. In addition, Dutch municipalities do seem to have identical ambitions in the domains of environment and mobility as Neirotti et al. (2014) identified in worldwide smart city applications.

This empirical research adds to the limited research data about smart city applications. It would be very good to see more extensive empirical smart city overview studies to be able to compare countries in their smart city ambitions relative to their factual activities and help them to position themselves in this respect. Furthermore, additional empirical research will help academics in understanding the smart city concept and its application and implementation more thoroughly and help countries that lag behind to catch up in these developments.

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