

# »» The smart city as a solution to municipal challenges?

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Cities, the economic and social centres of our society, are facing major challenges all over the world. The smart city is a concept for meeting these challenges. Innovative information and data-based instruments are to enhance the quality of life and resource efficiency of cities on a sustainable basis. The approach addresses various domains of city life. However, the dependence of smart city approaches on data and technology also poses substantial risks that need to be taken into account.

Germany's smart city initiatives are better than the European average but not in the top group. German municipalities still lag behind considerably, particularly in smart governance. In order to successfully shape the digital transformation of German cities, both a clear vision of the future city and sufficient funding for investment capacities and skilled workers are needed.

Cities are now home to more than half the world's population and this will be a staggering two thirds by the year 2050 – around 2.4 billion people more than today.<sup>1</sup> This growth poses enormous challenges. Most of the world's resources are consumed in urban regions.<sup>2</sup> As a consequence, there is a close correlation between urbanisation and greenhouse gas emissions (Figure 1). The ongoing trend towards urbanisation therefore has considerable impacts on the environment and the climate and, thus, on people's quality of life.

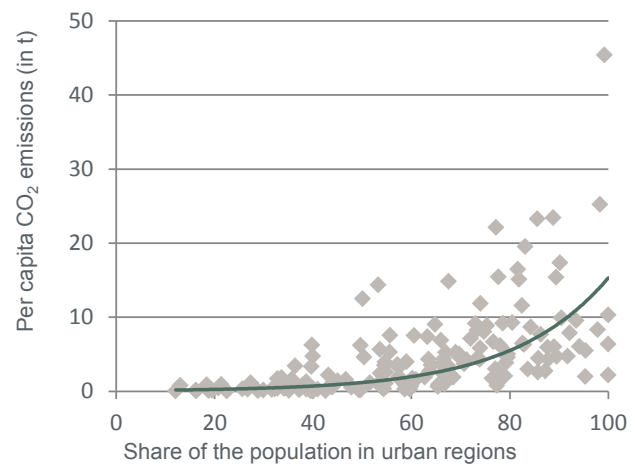
## Data and innovative technologies should help to meet challenges of cities

Cities are complex systems in which many different stakeholders interact. The necessary infrastructure must be permanently adjusted to the needs and numbers of users within a city. Variations in the population constantly pose challenges for cities. However, urbanisation trends differ across the globe. While urban populations are still growing rapidly in developing countries in particular, requiring completely new infrastructures, they are stagnating or declining in many industrialised regions. Adapting existing infrastructures is a greater concern there.

So to a certain extent, cities have very different perspectives but need to respond to similar global problems, such as climate change and location competition. At the same time, however, urban regions also have great innovative potential because of their extensive resources and their attractiveness for business and well-educated citizens. How can cities harness this potential to successfully manage urban

transformation, while playing their part in protecting the environment and the climate?

**Figure 1: More urban residents lead to more greenhouse gas emissions**



Note: The figure shows countries with at least 250,000 inhabitants.

Sources: United Nations (2014) – World Urbanization Prospects: The 2014 Revision, Weltbank – World Development Indicators, own calculation.

Some are pinning their hopes on smart cities – cities that “think” and thus operate sustainably. In these cities, resource consumption should be lower and the quality of life higher.<sup>3</sup> Given their growing importance, this paper aims to discuss key aspects relating to smart cities: What does smart city mean? Which areas of life can a smart city improve? What needs to be considered when developing a smart city?

## A uniform definition of smart city is still lacking

The concept of a smart city has not yet been uniformly defined but is interpreted differently depending on the focus area.<sup>4</sup> It is also difficult to identify uniform global trends for smart cities because the needs and conditions of cities vary greatly.<sup>5</sup>

Initially, the concept was heavily shaped by technology providers and the focus on the technological aspects of the smart city.<sup>6</sup> In recent years, however, interdisciplinary research has established a much broader concept of the smart city.<sup>7</sup> Two aspects characterise current approaches: a heavy focus on solutions involving information and communications technology (ICT) and the aim of improving urban living conditions.<sup>8</sup>

This goal can be pursued in various areas of urban life and activity. A smart city's domains vary with the respective definition. However, the literature frequently refers to the following six key interconnected domains: smart economy, smart people, smart governance, smart mobility, smart environment and smart living.<sup>9</sup>

**Smart economy: using cities' innovative power**

A smart economy aims to exploit the large innovative potential of cities to manage economic challenges and transformations. It aims to use the data and information potentials of cities to strengthen existing industries (for example by optimising production or service processes) or to promote the development of new industries (such as digital services for citizens and businesses).

**Smart living: harnessing the inclusive forces of digitalisation**

Smart living aims to improve citizens' quality of life through greater integration of ICT-based applications, for example by providing a more comfortable operation of wirelessly connected household appliances, from the coffee machine to the heater.

**Smart governance: bringing citizens and local governments closer together**

Smart governance aims to improve processes and interaction within local governments and between local governments and citizens. Besides using ICT, this requires the development of new possibilities for closer citizen participation and new ways of digital (citizen) involvement.<sup>10</sup>

**Smart environment: cities contribute to protecting the environment and the climate**

A smart environment is composed of intelligent solutions for lowering cities' energy and resource consumption. It involves better monitoring and control of environmental conditions, e.g. through permanent monitoring of air and water quality. It also enables and requires a greater share of renewable energies. ICT-based applications and infrastructures (e.g. smart grids) also enable energy supply and demand to be matched more efficiently.

**Smart mobility: intelligent solutions for efficient and resource-friendly transport systems**

The transport sector accounts for a large share of energy consumption and greenhouse gas emissions.<sup>11</sup> Other environmental impacts such as noise or air pollution are closely related to transport. An efficient mobility strategy should mitigate the negative impacts of the transport sector while meeting the high mobility demands of a modern society. Smart mobility also means using ICT-based solutions to achieve this while significantly reducing environmental contamination and noise pollution. Among other things, this includes further developing established mobility concepts (e.g. into autonomous and zero-emissions mobility concepts) and optimising transport flow, e.g. through real-time transport guidance systems. The inclusion of alternative mobility or urban strategies – such as compact cities which,

in an ideal scenario, can even operate without motorised transport – may also be part of a smart mobility strategy.

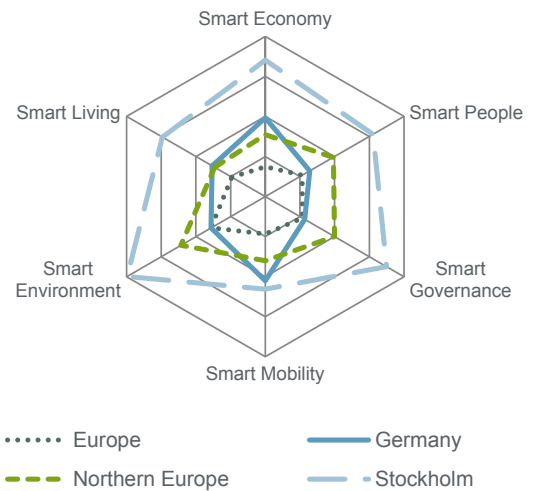
**Smart people: digital skills as a catalyst of smart transformation**

All these applications require digitally literate citizens and entrepreneurs who are able to use and develop them. Smart people are citizens whose digital skills are developed in a way that enables them to actively and creatively participate in designing and innovating the city, its economy and environment.<sup>12</sup>

**Germany's smart cities: good but not the best**

A successful smart city should be active in as many of the above dimensions as possible. How successful are Germany's smart cities so far? Rankings can provide initial information. The Technical University of Vienna developed a comprehensive ranking for medium-sized cities with 300,000 to one million inhabitants in 2007. It rated each of the now 90 cities in the ranking both for the individual dimensions and for their overall performance as a smart city.<sup>13</sup>

**Figure 2: Smart governance holds particular potential**



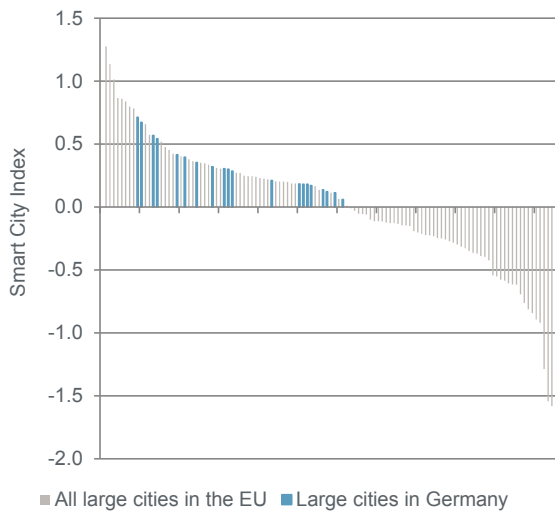
Note: The more sharply the corners of the hexagons point outside, the better the rating in the corresponding smart city dimension.

Source: smart-cities.eu, own calculation.

If we compare the rated German cities on the basis of the most recent results for 2015, we see that these score better than the European average in all dimensions (Figure 2).<sup>14</sup> It is also notable, however, that the German cities score above average in the categories smart economy and smart mobility but still lag significantly behind other northern European countries in the categories smart people and smart governance.<sup>15</sup> Compared with Stockholm, the highest rated city (see box), German cities actually rank equally only in the category smart mobility.

This is also evident in the overall ranking (Figure 3).<sup>16</sup> It is true that all German cities rank above average overall. But most still lag significantly behind Europe's top group.

**Figure 3: Germany's smart cities do not yet excel**



Note: Positive values represent above-average ratings, negative values represent below-average ratings.

Sources: smart-cities.eu, Easypark 2017 Smart City Index, own calculation.

**Successful development of smart cities requires innovative visions, people and processes**

What do successful smart cities have in common and how can German smart cities move up to the top group? Smart cities are often not clearly defined but rather reflect the characteristics of a city that is evolving through innovative processes.<sup>17</sup> Their different challenges also generate different strategies.<sup>18</sup>

**Stockholm's smart city initiative**

With the massive expansion of its fibre-optic network, Stockholm initiated its rise to global digital leadership already in 1994. Today, fibre-optic networks cover 100 % of its urban area.<sup>19</sup> Stockholm can also serve as a model in other dimensions such as:<sup>20</sup>

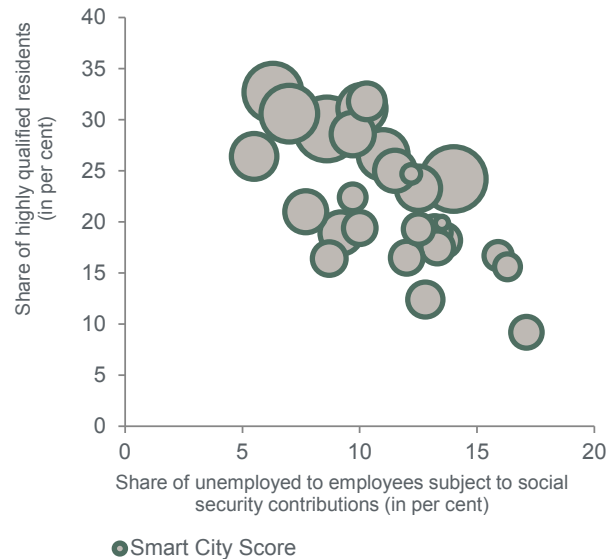
**Innovation culture:** Stockholm encourages all private and public stakeholders to actively contribute to strategy development. To this end it promotes continuing education measures in the digital context. The aim is to have a tech-savvy population that incorporates innovative solutions early into daily life. The pilot projects being developed are tested on a broad scale and under real-world conditions (e.g. in the renowned ICT cluster Kista Science City) in order to be able to better estimate the impacts that individual initiatives have on the city.

**E-government:** Stockholm offers a wide range of public online services. The 'digital administration' enables city council meetings to be followed and important formalities to be completed online. Real-time services, such as environmental and transport updates, provide benefits to citizens, for example through a public mobility tool that provides real-time updates about the best travel options in the city. Stockholm actively involves its citizens in strategy development in order to increase the acceptance of its services.

Many existing strategies and initiatives are therefore more easily assessed by their design and (initial) implementation than by their long-term impact. Successful or promising smart city initiatives have so far been those that are committed to measurable targets and indicators that are aligned with the city's political objectives or challenges and enjoy broad political and social support. Successful initiatives must therefore always aim to carry out actions with specific and measurable impacts. Successful strategies should also be scalable to larger dimensions, e.g. from one district to an entire city.<sup>21</sup>

The factors that are crucial to successful implementation can be briefly summarised under visions, people and processes. There is a need to have a clear idea of how the future city should be designed in the face of political and social challenges. This vision must be actively implemented by dedicated individuals in the local government, business and the populace. This requires suitable processes and institutions that support this implementation.<sup>22</sup> Empirical analyses also demonstrate that the development of specific smart city initiatives also depends heavily on local context factors.<sup>23</sup> These include the economic strength and size of the urban population, for example. Such context factors are also relevant for German smart cities (Figure 4).

**Figure 4: Economic strength and human capital are important factors for German smart cities as well**



Note: The illustration shows the correlation between smart city performance and the context factors economic strength (measured by the unemployment rate) and human capital (measured by the percentage of highly skilled workers among employees subject to social security contributions). It shows the 27 German cities for which rankings were presented by the TU of Vienna and Easypark.

Source: smart-cities.eu, Easypark 2017 Smart City Index, own calculation.

The size of the bubbles depicted is a measure of a smart city's performance. The larger the bubble, the higher the total score in the rankings mentioned. The position of the bubbles provides information on the prevailing conditions in the city. Positions on the left upper margin reflect many highly skilled and few unemployed inhabitants, while the lower right margin shows the exact opposite.

The illustration shows that the German smart cities with higher scores tend to have a higher share of highly skilled inhabitants and low unemployment. The existing situations of German cities, which can vary greatly, are therefore also reflected in the success of the relevant smart city initiatives.

## Data are the fuel that drives the smart city

The high importance of context factors, particularly a highly skilled population, can also be explained by the smart city's mode of operation: the use of large quantities of data. This requires it to develop and perfect innovative solutions both in the collection and in the use of data.

Data collection involves the use of some entirely new approaches. In addition to using fixed sensors, for instance, the inhabitants themselves can be involved in data collection, for example through their smart phones. The interconnection of household appliances (Internet of things) also provides new ways of collecting data.

But what is most important for a smart city is to use and evaluate the data meaningfully. The main focus needs to be on enhancing a city's responsiveness. That means continuously evaluating the available datasets in real time and so actively steering and optimising the intended target parameters – a smooth traffic flow, for example. To this end, data not only need to be collected and operationalised but connected between various data sources and translated into knowledge through an evaluation of integrated datasets. Not until this knowledge is available can 'smart' decisions be adopted that contribute to an inclusive, innovative and efficient city.<sup>24</sup> All of this requires innovative technical solutions and, hence, a comprehensive set of economic and intellectual resources.

## Risks of the smart city must be addressed

The smart city's dependence on data and technology places high demands on businesses and citizens, both as users and as originators of data and technologies. This carries substantial risks. Risks involving data sovereignty and the protection of privacy, operational and strategic risks and the risk of a digital divide appear particularly important in this context.<sup>25</sup>

The smart city raises fundamental questions about data sovereignty and the protection of privacy, also with a view to the possibility of combining various personal data. Apart from many useful applications, these data also open up entirely new possibilities for control, surveillance and data misuse.<sup>26</sup> Another question that arises is who owns the data collected by public and private institutions and businesses and how economic interest in the data can be reconciled with open data, personal rights and a smart city that serves the public interest.<sup>27</sup> So far, however, ethical and moral aspects of data collection and use are hardly being discussed by the public at large.<sup>28</sup>

Operational risks are another relevant safety aspect. As in all digital networks, there will be security vulnerabilities which hackers want to exploit. As the network grows, so does the

number of possible weaknesses. The threat of cyber attacks therefore rises in closely connected cities.<sup>29</sup> Moreover, high population density means that in a (smart) city a particularly high number of dwellers and users will be affected by malfunctions and breakdowns of critical (digital) infrastructures.

Not least, the differences in the possibility of accessing the benefits of digitalisation present a substantial social risk. Digitalisation generates many opportunities but these will not necessarily benefit everyone. In fact, digitisation can even exacerbate existing inequalities.<sup>30</sup> This risk exists not just within a city or community but also between regions that have different levels of financial and economic strength.

The implementing municipalities also face a strategic risk with regard to the investment they need to make in technologies and the financing instruments they use for them. The powerful position of global technology providers therefore requires municipalities to weigh these risks carefully and broadly.<sup>31</sup>

## German municipalities need a clear strategy, scope for investment and specialists

In Germany, a successful development of smart cities that takes into account the risks outlined above can take place only with and within the municipalities. First, they must provide and operate the critical infrastructure. Second, municipalities act first and foremost as a necessary hub and thereby enable cooperation between authorities, business and citizens.<sup>32</sup>

In order to fulfil this role in the transformation process, municipalities first need to have a clear idea and vision of their future design. Whether this is already the case in all German initiatives is questionable, as only around 15% of the cities shown in Figure 4 have published a smart city strategy. Almost 60% do not offer any publicly available information on their initiatives.<sup>33</sup>

In order for their digital transformation to be successful, in addition to a specific vision and strategy municipalities primarily need scope for investment and staff who enable them to implement the strategy on an equal footing with technology partners. A glance at the current investment and staff situation gives reason for concern here.

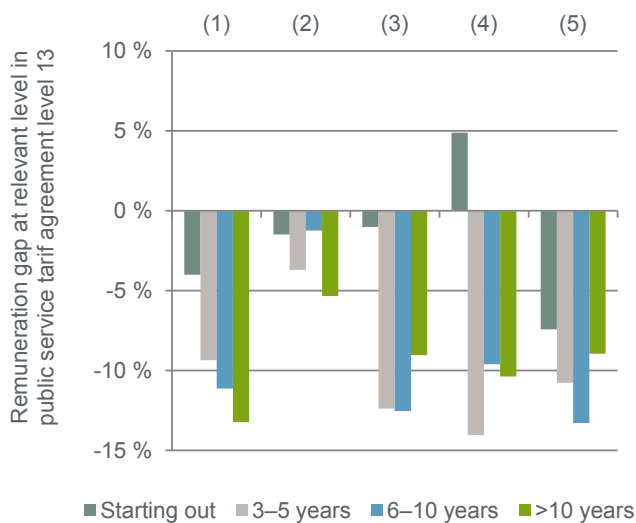
Germany's municipalities have very different scope for investment. Although it has dropped in the past year, municipalities' investment backlog has already reached a significant EUR 126 billion, of which EUR 5.9 billion is in the IT sector alone.<sup>34</sup> What is more, the most recent improvements were driven mostly by the business cycle and hardly by structural change.<sup>35</sup> Municipalities with weak finances will therefore be particularly challenged to find the funds needed for additional investment in smart city development and expansion.



Municipalities also face great staffing challenges. First, municipal employees are older on average than employees in the private sector or the public sector overall. Second, the current job key in the municipal sector is heavily geared to medium and higher intermediate civil service. However, technological transformation in particular requires highly skilled specialists such as computer scientists and engineers, who usually need to be employed in the higher civil service or on the basis of above-tariff compensation. The current job key, however, hardly provides any scope for this, as only around 3.5% of municipal jobs currently fall into these wage categories.<sup>36</sup>

The problem is additionally exacerbated by the fact that even in the higher civil service the salary structures still lag far behind the private sector, for example in important areas of the IT sector (Figure 5). The remuneration gap is likely to make it difficult for municipalities to recruit the necessary personnel. This is also because municipalities compete with federal and state agencies which employ significantly more personnel on higher remuneration levels.

**Figure 5: Public servants earn significantly less than workers in the private IT industry**



Note: (1) SAP/ERP advice, (2) software development, (3) IT consulting & engineering, (4) business intelligence & data analysis, (5) project management.

Sources: Federal Statistical Office and Stepstone Salary Report 2017 for professional and managerial staff, own calculation.

### All levels are called upon to improve infrastructure, overall frameworks and digital skills

The good news is: smart cities can be planned and designed actively.<sup>37</sup> For this to succeed, however, policymakers must insist on having design leeway and avenues of intervention and ultimately they will have to use them with impetus contributed by the citizenry.

For urban development policy it will be particularly important to develop strategies and guiding principles. Their design and implementation should then be guided primarily by the key concepts of independence, security, decentralisation, openness and civic orientation. Thus, it should be

independent of individual technology providers and open with respect to data and access in order to make the systems as resilient and innovative as possible. It should also be strictly oriented to the citizens on the basis of needs-based services. It should also be decentralised and secure through an optimal degree of integration, high transparency, open source and regular inspections by independent institutions.<sup>38</sup>

A number of supporting hard and soft factors are also required.<sup>39</sup> For example, urban infrastructure needs to be further improved. The expansion of broadband services needs to be pursued systematically and thought through beyond the scarcely ambitious interim target of 50 Mb per second.

The risks of a smart city put the legal and regulatory framework to the test on all policy levels.<sup>40</sup> This poses great challenges for local governments. Adjustments to their personnel strategy and at least a restructuring towards highly qualified positions appear to be inevitable. In addition, small and financially weak municipalities in particular should pool their knowledge and, wherever possible, financial strengths, for example in the form of joint procurement or jointly developed solutions.

In the necessary transformation, care must also be taken to avoid creating a digital divide in society. Applications must be intuitive and accessible so that they can be used by all citizens without any restrictions. To this end, citizens' digital skills must be further developed, particularly for population groups that are at high risk of being left behind, such as aged persons or those with less education. Significant progress also needs to be made in e-government.

It also needs to be taken into account that the favourable context factors vary greatly across Germany's regions, which poses another risk of a digital divide opening up.<sup>41</sup> A national smart city strategy therefore must also develop solutions that allow economically weaker or peripheral regions to benefit from the advantages of digitalisation.<sup>42</sup> In Germany, the Smart City Charter<sup>43</sup> that is being supported by the Federal Government has been in effect since May 2017. It addresses almost all aspects discussed here, their objectives and recommended course of action. It places a particular focus on the participatory forces of the smart city. The current coalition agreement also addresses digitalisation and smart city concepts. The challenge will now be to implement the formulated objectives with specific policy measures.

The general rule here is to critically question old patterns of thought in the face of great challenges and scarce resources.<sup>44</sup> What resources and skills do municipalities themselves need? How can partnerships between communities or at district level ease pressures or even deliver better results? How can cities and regions cooperate with their surrounding areas? The aim should be to avoid inefficient stand-alone solutions. Existing approaches and strategies should therefore be assessed dispassionately and examined for transferability. The Smart Cities dialogue

platform<sup>45</sup> could be established and developed further as a necessary point of contact.

## Conclusion

Smart cities provide great potential for significantly improving urban living conditions. No region can avoid the trend towards smart cities. Location competition is already generating great pressure on cities and regions to make adjustments and the smart city can become a key locational advantage.

But to achieve this, municipalities must fill this concept with life. In order for the digital transformation of Germany's cities to be successful, what they need more than anything is a vision of what the city of the future should look like, sufficient

investment capacities and skilled workers who can implement this vision in the administrative structure.

The path to the smart city must be taken with foresight to prevent the utopia of a more liveable city from ending in new system dependencies, posing functional risks or creating a digital divide between its citizens. The conditions are good for tackling these challenges now and thus improving the quality of life in Germany's cities and communities on a sustained basis. ■

Further publications and information from KfW Research on the thematic area 'Municipalities and infrastructure' can be found at [www.kfw.de/research-kommunen](http://www.kfw.de/research-kommunen)

<sup>1</sup> Cf. United Nations (2014). World Urbanization Prospects: The 2014 Revision. United Nations, Department of Economic and Social Affairs, Population Division.

<sup>2</sup> Cf. Hoomweg, D. et al. (2011). Cities and Climate Change: Responding to an Urgent Agenda, The World Bank, 2011.

<sup>3</sup> Cf. German Advisory Council on Global Change (2016): Der Umzug der Menschheit: Die transformative Kraft der Städte (*Humanity on the move: the transformative power of cities, Flagship report of the German Advisory Council on Global Change* – our title translation, in German only), Berlin 2016.

<sup>4</sup> For a detailed description of how the concept developed and the various approaches to its definition see e.g. Cocchia, A. (2014): Smart and Digital City: A Systematic Literature Review. Progress in IS, p. 13–43 or Albino, V. et al. (2015): Smart Cities: Definitions, Dimensions, Performance, and Initiatives, Journal of Urban Technology, 22 (1), p. 3–21.

<sup>5</sup> Cf. Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., and Scorrano, F. (2014). Current trends in Smart City initiatives: Some stylised facts. Cities, 38, p. 25–36.

<sup>6</sup> In 2008 IBM was one of the first companies dedicated to aspects of digital urban and environmental design under the label of 'Smart Planet'. Many other corporations developed the 'smart' label further, including Cisco, HP or Siemens. Cf. Cocchia, A. (2014): loc.cit. This is driven by a promising earnings outlook; Forbes sees smart cities as offering global market potential of USD 1.5 trillion, cf. Singh, S. (2014) Smart Cities – A \$1.5 Trillion Market Opportunity, 19 June 2014, retrieved on 12 January 2018 at [www.forbes.com](http://www.forbes.com)

<sup>7</sup> Cf. Mora, L. et al. (2017): The First Two Decades of Smart-City Research: A Bibliometric Analysis. Journal of Urban Technology 24(2), p. 3–27.

<sup>8</sup> A smart city thus becomes a city that seeks to solve social and urban challenges using ICT-based approaches. It aims to permanently improve local living conditions through local initiatives that involve many different stakeholders. Cf. e.g. Mannville et al. (2014): Mapping Smart Cities in the EU, European Parliament, Policy Department A: Economic and Scientific Policy, January 2014.

<sup>9</sup> Giffinger et al. (2007) follow this classification: Smart cities ranking of European medium-sized cities, Final Report, Vienna, October 2007. Other studies also follow this classification, e.g. Mannville et al. (2014) loc cit. or follow similar approaches. Neirotti, P. et al. (2014) loc. cit. also chose six categories with a slightly different design.

<sup>10</sup> Cf. UN (2014): United Nations E-Government Survey 2014 – E-Government for the Future We Want, United Nations, New York 2014.

<sup>11</sup> Cf. Römer, D. (2017): Deutschland – Land der Autofahrer: Wie steht die Bevölkerung zur Verkehrswende? (*Germany – a country of drivers: what does the population think about the mobility transition?* – our title translation, in German only) Focus on Economics No. 187, KfW Research.

<sup>12</sup> These abilities are summarised under the term 'digital literacy'. Cf. Knobel, M. (2008). Digital literacies: Concepts, policies and practices, Vol. 30, Peter Lang.

<sup>13</sup> To explain the six dimensions, 27 competency areas are defined which for their part are assessed on the basis of 90 indicators. Cf. Giffinger et al. (2007) loc. cit.

<sup>14</sup> The German cities included in the ranking are: Frankfurt a. M., Stuttgart, Düsseldorf, Hannover, Leipzig, Bielefeld, Dortmund, Bremen, Dresden, Mannheim, Wuppertal, Essen, Bochum, Bonn, Duisburg and Nuremberg. The informative value is somewhat restricted as some pioneer smart cities such as Berlin or Friedrichshafen are not included in the ranking.

<sup>15</sup> These include Belgium, Denmark, Finland, France, Ireland, the Netherlands, Sweden and the United Kingdom. Other studies also agree with the assessment that a high need for catching-up exists particularly in the field of e-governance. Cf. National Council for the Review of Legal Norms (2016): E-Government in Deutschland: Wie der Aufstieg gelingen kann (*E-government in Germany: how progress can succeed* – our title translation, in German only), June 2016.

<sup>16</sup> This statement is true even when we include Germany's large cities in the assessment. To this end, we combined the smart city scores of the TU of Vienna with the scores of Easyparkgroup. We then analysed the overlap of cities in both scores. On the basis of coefficients estimated in a linear regression, we determined indicators for the German large cities that are comparable to the TU of Vienna scores. The explanatory content of the estimation model is very high so a very good approximate solution can be assumed. In this way, overall scores can be mapped for 114 large European cities.

<sup>17</sup> Cf. BBSR (2014): Auf dem Weg zu Smart Cities (*On the way to smart cities* – our title translation, in German only), BBSR-Analysen KOMPAKT 04/2014.

<sup>18</sup> A majority of smart city initiatives are still in an early stage, making an assessment more difficult as well. Cf. Mannville et al. (2014), loc. cit.

<sup>19</sup> For comparison, in the precursor city of Friedrichshafen, under the T-City pilot project the project partner Telekom expanded the less powerful VDSL broadband technology with target bandwidths of 50 Mb per second as recently as in 2007. Cf. <http://www.t-city.de/>.

<sup>20</sup> Here we discuss selected aspects only. For a detailed description of Stockholm's smart city approaches see Angelidou, M. (2016): Four European Smart City Strategies, International Journal of Social Science Studies, 4 (4), S. 18–29 und <https://international.stockholm.se/city-development/the-smart-city/>.

<sup>21</sup> A successful strategy should in any case be directed more towards a smart region than a smart city, since it is only in this way that effects between the city and its environs can be adequately considered, cf. Ramaswami, A. et al. (2016), loc. cit. For a detailed discussion of successful smart city initiatives see, for example, Mannville et al. (2014), loc. cit.

<sup>22</sup> Cf. Mannville et al. (2014) loc. cit.

<sup>23</sup> For a discussion of possible context factors see, for example, Neirotti, P. et al. (2014), loc. cit.

<sup>24</sup> Cf. Ramaswami, A. et al. (2016). Meta-principles for developing smart, sustainable, and healthy cities. Science, 352(6288), p. 940–943 und World Bank (2016): World Development Report 2016: Digital Dividends.

<sup>25</sup> Cf. German Advisory Council on Global Change (2016), loc. cit.

<sup>26</sup> Cf. Kitchin (2016): Getting smarter about smart cities: Improving data privacy and data security. Data Protection Unit, Department of the Taoiseach, Dublin, Ireland.

<sup>27</sup> Questions surrounding data protection in bike-sharing schemes are a recent example. Cf. FAZ (2018): Verbraucherschützer warnen – Fahrrad-Wahn in unseren Innenstädten (*Consumer protection groups warn – bicycle madness in our inner cities* – our title translation, in German only), FAZ online of 5 February 2018, retrieved on 6 February 2018.

- <sup>28</sup> Cf. BBSR (2014), loc. cit.
- <sup>29</sup> Cf. Kitchin (2016), loc. cit.
- <sup>30</sup> Thus, differences in network access or digital skills may lead to an unequal distribution of the benefits of digitalisation. Cf. World Bank (2016), loc. cit.
- <sup>31</sup> This applies, in particular, to their negotiations of the terms of medium- and long-term investment related financing agreements. Cf. BBSR (2014), loc. cit.
- <sup>32</sup> Cf. BBSR (2014), loc. cit.
- <sup>33</sup> On the other hand, not every city has to pursue an integrated smart city design, as individual smart sub-aspects may be sufficient for it to achieve its municipal development targets. Cf. Libbe, J. and Soike, R., (2017): Smart City-Vernetzung braucht klare Struktur (*Smart city connections need a clear structure* – our title translation, in German only), der gemeinderat, 10/2017, p. 34–35.
- <sup>34</sup> See Scheller, H. et al. (2017): KfW Municipal Panel 2017, KfW Group.
- <sup>35</sup> See Brand, S. and Steinbrecher, J. (2017): Rückgang des Investitionsrückstands – Trendwende oder nur Schönwetterlage? (*Declining investment backlog – a trend reversal or just a temporary breather?* – our title translation, in German only) Focus on Economics No. 195, KfW Research (in German).
- <sup>36</sup> Cf. Federal Statistical Office, public service personnel and statistics of Federal Employment Agency staff subject to social security contributions
- <sup>37</sup> Cf. Bieber, C. and Bihr, P. (2015): Digitalisierung und die Smart City, Expertise für das WBGU-Hauptgutachten „Der Umzug der Menschheit: Die transformative Kraft der Städte“ (*Digitalisation and the smart city, expertise for the flagship report of the German Advisory Council on Global Change 'Humanity on the move: the transformative power of cities'*, - our title translation, in German only), Duisburg 2015.
- <sup>38</sup> For a detailed discussion see BBSR (2014) loc. cit. and Bieber, C. and Bihr, P. (2015) loc. cit.
- <sup>39</sup> Hard factors and areas of a smart city essentially include classic infrastructure such as energy networks or broadband infrastructure. Soft factors rather address accompanying social concerns such as education, culture and e-government. Cf. Neirotti, P. et al. (2014), loc. cit.
- <sup>40</sup> Cf. Kitchin (2016), loc. cit. The international exchange of data and information also requires supranational institutions to develop global standards for the management of digital risks. Cf. German Advisory Council on Global Change (2016), loc. cit. This also requires a pronounced problem awareness among policymakers and local governments. Their current policy targets at least suggest that the importance and need to manage the digital transformation are not yet being sufficiently addressed. See e.g. FAZ Online 'Digitalisierung zerstört 3,4 Mio. Stellen' (*Digitalisation destroys 3.4 million jobs* – our title translation, in German only), retrieved on 2 February 2018.
- <sup>41</sup> Here it must also be taken into account, for example, that the increased controllability of a smart city is usually associated with higher resource expenditure. Cf. BBSR (2014), loc. cit.
- <sup>42</sup> Cf. for example Liggesmeyer, P. und Swarat, G. (2017): Digitale Strategien im ländlichen Raum: Herausforderungen und Chance (*Digital strategies in rural regions: challenges and opportunities* – our title translation, in German only). Der Landkreis 87/November 2017, p. 687–688.
- <sup>43</sup> Retrievable from: [http://www.bbsr.bund.de/BBSR/DE/Veroeffentlichungen/Sonderveroeffentlichungen/2017/smart-city-charta-dl.pdf?\\_\\_blob=publicationFile&v=2](http://www.bbsr.bund.de/BBSR/DE/Veroeffentlichungen/Sonderveroeffentlichungen/2017/smart-city-charta-dl.pdf?__blob=publicationFile&v=2).
- <sup>44</sup> Cf. e.g. Schulz, S.E. (2017): Digitalisierung und Verwaltung: Ein Plädoyer für mehr Kooperation (*Digitalisation and local governments: a plea for more cooperation* – our title translation, in German only). Der Landkreis 87/November 2017, p. 690–693.
- <sup>45</sup> For further information on the platform cf. <http://www.bbsr.bund.de/BBSR/DE/FP/ExWoSt/Studien/2015/SmartCities/smart-city-dialog/start-node.html>.