SMART CITIES

Further praise for *Smart Cities*:

Smart cities require suitable technologies, sustainable business models, and proper administration processes. This book conveys concrete ways of how cities can become smart cities.

– Oliver Deuschle, SMIGHT at EnBW, Germany

This book succinctly expresses why only one smart city can persist in face of location competition.

– Yvonne Beutler, Vice President of City Council, Switzerland

Digitalization opens up myriad development possibilities in cities. This book expertly delineates various "best practices" as well as core elements of a systematic and strategic approach.

– Prof. Thomas Schildhauer, Humboldt Institute for Internet and Society, Germany

Municipal utilities not only construct and operate essential digital infrastructure, but also new services for a smart city – from waste disposal "on demand" to electromobility. This book can especially assist small public utility companies in their efforts to develop and realize a strategy for their smart city.

– Katherina Reiche, Verband kommunaler Unternehmen e.V., Germany

The realization of smart city projects presupposes a uniform understanding of their relevant dimensions. This book and its smart city management model offer the ideal foundation for this crucial unification.

– Orlando Gehrig, Swisspower Innovation, Switzerland

SMART CITIES

Introducing Digital Innovation to Cities

BY

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PREFACE

The concept of the "smart city" promises to solve many of the urgent issues that accompany progressive urbanization – overwhelming traffic congestion, strains on energy and water systems, delinquency, inadequate housing, and the lack of social inclusion – through digitalization. Smart cities are therefore highly relevant for political decision makers in municipalities, administrative agencies, and nonprofit and civic organizations. Moreover, smart or "ecosystem" cities offer great potential for countless corporations in the fields of information technology, real estate, telecommunications, energy supply, auto-mobility, sensor systems, and data analytics. Accordingly, it is not surprising that numerous highly innovative companies, including IBM, Cisco, Telekom, Siemens, Toshiba, and Google, along with public utilities around the world, are actively investing in smart city development. Additionally, many startups are concurrently entering the Internet of Things (IoT) and energy fields, placing competitive pressure on established firms.

The social and political demands of the energy revolution, combined with the auspicious possibilities of an interconnected yet decentralized world within the framework of IoT, are accelerating the transformation of urban centers toward becoming smart cities. Despite the exploitation of existing potentials by "lighthouse" (i.e., pilot) cities, such as Barcelona, Munich, Lyon, and Vienna, most municipalities have pursued smart city opportunities only to a limited extent thus far. As a result, the discrepancies between leading smart cities and less ambitious cities are widening. The need for action is frequently discerned, yet the most appropriate path of action often remains unclear.

Various important questions about smart city development are still unanswered. What are the core elements of smart cities? What steps should be followed in building them? Where does the greatest potential lie? What is the ideal starting point? What procedures have other cities applied? What can be learned from pioneers in the field? Are the successes of the greenfield approaches applied by Asian smart cities transferable to other parts of the

world? What methods and tools can be usefully implemented? What business models have participating firms used? How can diverse stakeholders be effectively integrated?

This book answers these questions in the form of solution paths, accompanied by design concepts and success factors. It covers the following main topics:

- the future of cities;
- an overview of smart cities;
- smart city management model;
- smart city lighthouses;
- guidelines for smart city transformation; and
- tools for making your city a smart city.

Cities today face tremendous challenges concerning livability, mobility, energy, and communication. These challenges are forcing them to reconsider their former self-conception, their functionality, and their service offerings. However, cities that focus actively on their objectives and on the requisite digital transformation can imagine and realize entirely new living spaces. To help them achieve this goal, they should learn from the experiences of pioneers in the field, which we call lighthouse cities. Urban centers can orient their strategies around the solutions and experiences of these role model cities, so as to design and execute their own situation-specific, customized transformation. These smart city management models serve as reference frames that provide basic fundamentals, offer recommendations for action, and contribute to the synchronization of the transformation process. The models are especially valuable as orientation tools introducing all stakeholders in a city or region to the smart city concept.

This book is based on ongoing research undertaken by the Institute of Technology Management (ITEM) and the Center for Energy Innovation, Governance, and Investment at the University of St. Gallen. Worthy of particular mention are the European Union project "Smarter Together," the national energy research program comprising eight Swiss Competence Centers for Energy Research (SCCERs), and numerous projects of the ITEM with partners from the spheres of politics, administration, and the economy.

The target audience for this book includes all stakeholders involved in a smart city transformation:

- Mayors, council members, administrators, and managers who must understand the impact of a smart city transformation and wish to be informed about promising paths of action.
- Decision makers in corporate settings (e.g., executives, innovation and R&D leaders, project directors, product managers, and startup entrepreneurs) who are involved in the realization of smart cities.
- Citizens who want to have a better understanding of future conceptions of their living environment.

A book is always a collaborative learning process.[1] We thank our partners in Smarter Together, which we were able to assist in the development of business models for the lighthouse projects and that in return gave us great insights in the process of developing a smart city. The concrete implementation example in the city of St. Gallen was developed in close collaboration with the municipal utility of St. Gallen (sgsw). We are particularly grateful to Marco Huwiler and Céline Hähni as well as the mayor of St. Gallen, Thomas Scheitlin who gave great insights and wrote the case study on St. Gallen. Very special thanks further go to Karin Klöti, Adrian Joas, and Laura Caviezel for their detailed research on the case studies, Simon Kuster for the elaboration of smart city business models, and Matthias Sulzer, Andrea Perl, and Kilian Schmück for their assistance with the sections on smart energy, smart mobility, and smart government. Lastly, we especially thank Pete Baker, Katy Mathers, and the entire Emerald team for making this book possible.

The urban challenges of the future require more intelligent concepts at all levels. The tools, processes, checklists, tips, and general experiences that have arisen from our research and practice-related work and are presented in this book can facilitate the development of such key concepts by decision makers. They provide a solid foundation for a diverse range of smart city transformation projects.

We hope that these concepts will spread, and we wish all individuals responsible for the realization of smart city elements much success in the development of sustainable environmental, social, and economic solutions.

NOTE

1. For a full and detailed description of all the contributions, see the acknowledgements.

HOW TO USE THIS BOOK

This book is designed as a standard, practical reference for executing smart city transformations. It should give everybody involved the necessary background understanding and tools to get their hands dirty. Here is how we suggest that you use it.

First: Get an overall understanding of what a smart city can be, what the challenges are, and where the topic is heading. Focus on the big picture; don't get buried in specifics, which will change rapidly with new developments and technology improvements.

Second: Pay very close attention to the Smart City Management Model. This comprehensive model is not an academic exercise; it needs to be applied. It can become the most central management tool in your own smart city projects. You may wish to adjust it slightly, but be sure to involve your stakeholders in any revisions.

Third: Find inspiration from how other cities have pursued transformation by reading about the model cities' lighthouse projects and reviewing the section on tools.

Finally: *Engage!* The full potential of this book, and especially of the Smart City Management Model, emerges when it is shared with others. To build consensus among all stakeholders, focus on execution rather than on differences in definitions. For example, hold a kickoff meeting with your stakeholders and discuss who will be responsible for each part of the model.

Shortcuts: The book addresses many different stakeholders in smart city transformations and tries to be as comprehensive as possible. In view of that structure, particular stakeholders might appreciate knowing a few shortcuts to the content most relevant to them:

- *The decision maker*: Chapters 1 and 2 explain what a smart city is and how to manage it. These are the most important chapters for you. If you want further detail on large cities, read the case studies. For smaller cities (around 100,000 people), the example of the Swiss city St. Gallen in Chapter 5 shows that every city has the potential to take meaningful action!
- *The implementer*: If you are in charge of managing implementation and need the right tools, tips, and tricks to guide you, first familiarize yourself with the Smart City Management Model. Then jump right into the tools section and do the analysis of your city's maturity level.

THE FUTURE OF CITIES AND THE CONCEPT OF SMART CITIES

The 19th century was a century of empires, the 20th century, a century of nation states. The 21st century will be a century of cities

– Wellington Webb,
Former Mayor of Denver,
Colorado, United States[1]

Cities are both a curse and a blessing. On the one hand, they contribute to sustainability in important ways. Their inhabitants are more eco-friendly, produce less CO_2, and earn a higher average income (GDP per capita) than rural residents. On the other hand, cities are often associated with crime, air pollution, health problems, high population density, increased soil sealing, social conflicts, and traffic issues. The smart city concept attempts to confront these negative aspects of cities with innovative, technology-based approaches. Smart cities are introducing and disseminating competitive advantages on an international scale.

China has incorporated smart cities as an integral component of its urban planning, followed by India with its "100 Smart Cities" plan. The number of smart city projects is growing daily. The Japanese firm Panasonic is constructing a new residential district, "Future Living Berlin," in the city's Adlershof section, including 69 housing units with electricity and heat flow automatically regulated. Microsoft founder Bill Gates has recently purchased a tract of land in Arizona where he hopes to create a high-tech city with a high-speed cyber-network, data centers, and autonomous vehicles. Furthermore, a futuristic $500 billion megacity showcasing, among other

things, passenger drones has been planned for the desert sands of Saudi Arabia, under the leadership of former Siemens CEO Klaus Kleinfeld.

These developments are making the very nature of the city a center of attention with regard to the sustainability of regions or nations. In the first part of this book, we consider why this is the case, what the smart city concept truly offers cities beyond the facade of glossy brochures created by technology firms, and where typical implementation obstacles can be expected.

Despite the often-cited examples of smart megacity projects, across the globe small and medium-sized cities are increasingly struggling with rapid changes as well. Although the proportion of the world population living in megacities (i.e., cities with more than 10 million inhabitants) has grown to 5.3% in 2010 (compared to 1.4% in the 1960s) and will reach 7.9% in 2025 according to projections, small and medium-sized cities (with between 300,000 and 5 million inhabitants) have experienced equally rapid development: The proportion of the global population living in such cities increased from 11.2% in 1960 to 15.4% in 1990 and then to 19% in 2010, and it is projected to reach 22.4% by 2025. In other words, far more people live in modest-sized cities than in megacities. This frequently ignored fact leads inevitably to the conclusion that medium-sized cities and their municipalities should assume a predominant role with respect to smart city initiatives in Europe. These cities will be responsible for spreading smart city ideas. Thus, this book examines the very specific challenges of such cities.

NOTE

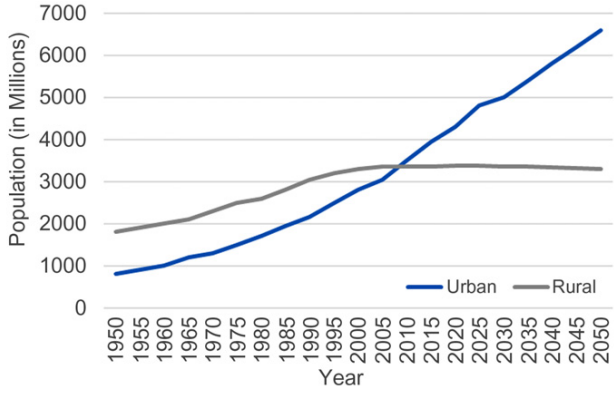
1. Huffington Post, 2017.

CHAPTER 1

THE FUTURE OF CITIES

The projections convey a clear message: cities represent the living environment of the future. The "century of the city" has been a crucial theme preoccupying politicians, business developers, city planners, public authorities, and citizens in recent years (Figure 1.1).

Figure 1.1. The Worldwide Urban and Rural Population from 1950 to 2050.



Source: United Nations (2015).

CITIES AS A MEGATREND

The importance of cities for the future of civilization becomes evident when one considers the following facts:

- Worldwide, more individuals are living in cities than in rural areas. In 2014, 54% of the human population resided in cities, whereas in 1950, city dwellers constituted only 30% of the global population.
- In 2040, 65% of the global population will be living in cities.
- Every second two persons move into a city worldwide.
- In 2050, 70% of the global population will be living in cities. Urban societies will consume 80% of total energy, produce 75% of total CO_2 emissions, and expend 75% of resources.
- Urban centers possess massive appeal. The three most popular city hashtags on Instagram in 2016 (#NYC, #London, #Paris) were mentioned in more than 180 million tweets.

The growth of urban economic centers is already causing the importance of countries to diminish. Silicon Valley, the epitome of innovation in the digital age, is competing with cities such as Shanghai, Boston, and Bangalore, rather than with nations such as India or China. This trend toward the increasing importance of cities, which may even surpass the significance of nations, not only entails bright prospects for urban areas but also great challenges: noise, smog, mobility bottlenecks, tightly constrained living spaces, overloaded energy and communication infrastructure, the redefinition of the urban role, modifications of existing structures, and social challenges related to living and working.

The challenges confronting cities vary significantly depending on the region and the city's size. Massive urban regions such as Tokyo–Yokohama, Jakarta, Delhi, Manila, Shanghai, and Mexico City have all exceeded 20 million inhabitants and have experienced enormous population growth in the last few decades. These cities have very different challenges and opportunities from cities such as Stuttgart, Porto, Halifax, Richmond, or Boise.

Urbanization Across the World (United Nations, 2017)

Africa: Africa has the lowest level of urbanization, with an annual urban growth rate of 4%. The number of cities in Africa with more than one

million inhabitants has grown rapidly from 28 in 1995 to 43 in 2005 and 59 in 2015. It is expected that the number of individuals experiencing urbanization will rise from 413 million (2010) to 569 million (2020).

Asia-Pacific region: About half of all people living today are in Asia, which is experiencing rapid urbanization, largely due to the industrialization of China and India. The impact of Asian cities on the world stage is increasingly apparent. In global city rankings, based on its gross domestic product, Shanghai is expected to rise from 25th place in 2008 to 9th place in 2025. The number of city dwellers in this region will increase from 1.675 billion (40% of all residents) in 2010 to 2.086 billion (47%) in 2020.

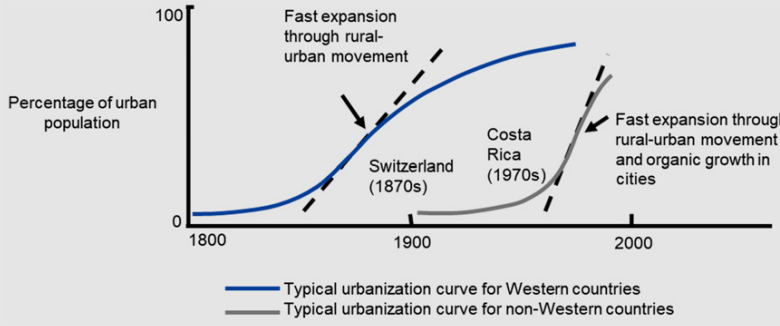
Latin America: Demographic changes during the past century have prompted the development of a highly urbanized structure in Latin America. About 540 million Latin Americans (78% of the total population) are living in cities. However, regional differences exist. In some South American countries, the proportion of city residents has approached 90%, whereas in Central America this demographic group represents only 50% of the population. As a whole, the urbanization level for the entire region is expected to increase to about 83% by 2020.

North America: In contrast to Africa, Asia, and Latin America, North America is experiencing relatively moderate population growth (0.9% annually between 2000 and 2010), 75% of which is occurring in metropolitan areas. However, this growth is not uniform. In fact, the suburban growth rate was three times as high as that of inner cities. Migration from northern to southern regions has occurred, leading to especially high population growth in suburbs of southern US cities. Nonetheless, large cities are still growing due to the high proportion of immigrants, which balances out the flight of other Americans away from cities. It is projected that the degree of urbanization is continuing to increase from 82% (2010) to 85% (2020).

Europe: Urbanization patterns in Europe are similar to those in the United States, with both differing sharply from demographic developments in the rest of the world (see Figure 1.2). Various trends in Europe have caused conceptions of the city to evolve constantly and have posed significant challenges. In Europe, growing populations are not a major factor in urban development; in fact, during the last century, one-third of European

cities experienced a population *decrease* while another third had no significant change. Projections indicate that the degree of urbanization is increasing only slightly from 73% (2010) to 75% (2020).

Figure 1.2. Typical Development of Urbanization in a Western and a Non-Western Nation.



CURRENT CHALLENGES FOR CITIES

City planners are confronted by new and constantly changing sources of tension and strain. Consider the following surprising facts:

- In San Francisco, 4% of municipal waste is produced by domestic animals, and that percentage continues to grow.
- In Germany, 320,000 coffee-to-go paper cups per day are consumed, leading to 40,000 tons of waste every year.
- The Swiss city of Basel has 31,000 public parking spaces and 69,000 more on private property, whereas the city's residents have registered only 57,000 automobiles. This is not efficient.
- The average speed of tramways is 15.4 km/h. Subways meanwhile drive at an average speed of 31.3 km/h.
- 80% of buildings in Europe will still exist in 2050.
- Drivers in Frankfurt am Main spend on average 65 hours each year searching for a parking space, resulting in costs amounting to 1,419 euros (Statista, 2017).