



Demystifying Smart Cities

Practical Perspectives on How
Cities Can Leverage the Potential of
New Technologies

—
Anders Lisdorf

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Demystifying Smart Cities: Practical Perspectives on How Cities Can Leverage the Potential of New Technologies

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About the Author

Anders Lisdorf has worked with innovative technologies for more than a decade in many different settings and industries. The last couple of years, he has been responsible for developing the data services of New York City, but previously he has worked as an entrepreneur, taught at the university level, and worked as a consultant. You can find him online and read more on his blog at www.lisdorf.com.

About the Technical Reviewer

Ahmed Bakir is an iOS author, teacher, and entrepreneur. He has worked on over 30 mobile projects, ranging from advising startups to architecting apps for Fortune 500 companies. In 2014, he published his first book, *Beginning iOS Media App Development*, followed by the first edition of *Program the Internet of Things with Swift for iOS* in 2016 and the second edition in 2018. In 2015, he was invited to develop courses and teach iOS development at UCSD Extension. He is currently building cool stuff in Tokyo! You can find him online at www.devatelier.com.

CHAPTER 1

Introduction

One of the first musical memories I have is Queen’s music video for “Radio Gaga” in which a bleak future city with flying cars and high rises is portrayed. For some odd reason, I ended up seeing the film that provided the background footage, Fritz Lang’s visionary 1927 film *Metropolis*, when I was in first grade at the local library. This left a lasting impression on me about the future of life in cities and the possibilities and challenges they would provide.

Whether we think about the flying cars of a bleak future city in Fritz Lang’s *Metropolis*, the hidden underground cities of *The Matrix*, or the city planet Coruscant in the *Star Wars* universe, cities have been a major object of focus for the imagination for centuries. Whether dystopian or utopian, fiction generates expectations and an impetus that drives us to develop new solutions that alter our reality. Cities are a fact of life and will be in the foreseeable future, which is why we have to reflect on how we want our future cities to be and how we can realize that. Switching from the dystopian outlooks of *Metropolis*, this book is about turning fiction into fact by understanding the practical details of leveraging technology to make cities more livable, sustainable, resilient, and prosperous. The book is intended for a nontechnical audience ranging from decision makers over civil servants to business people. For those who want to dive into more technical detail, references are provided at the end of the book for each chapter. The introduction will give an overview of the history of urbanization and look toward the future of cities. We will look at what smart cities are, the primary actors, and the primary area in order to build

a foundation for understanding the different parts of the puzzle and how they fit into the larger context. At the end is a brief outline of the book.

The history and future of cities

Human civilization is inextricably tied to cities. The very term civilization comes from the Latin “civilis” meaning everything related to being a citizen (also from Latin “civis”). This connection is however not just a linguistic artifact of Western culture.

When civilizations began appearing around 3500–3000 BC, in what is called the Fertile Crescent in present-day Middle East, they were all based and grew from cities. The original format well known through millennia was that of the city-state. One of the very first documented city-states is Uruk in ancient Mesopotamia. Other city-states appeared in the same area and spread to Egypt and then the wider Mediterranean.

Although not historically related, similar patterns of urbanization and empire-building were found through the following millennia in China, Mesoamerica (the Maya), and South America (pre-Inca and Inca) and about a thousand years ago in Western Africa. It is as if a wildfire spread through human culture across the globe fueled by urbanization, because on the scale of human development, 5000 years is only a short period of time.

From the very beginning, cities have been dependent on technologies to sustain life and produce ever more sophisticated tools and technologies. The Roman cities would never have been able to grow to the size they did without the aqueducts leading water into all corners of the city. The Egyptians would never have been able to build their marvelous temples and pyramids without their ramps and maps. It is as if the city creates and is created by technologies in an ever-ascending reinforcement loop.

Historically, cities were the exception, with hunter/gatherers as the norm, but today urbanization is a fact of life that very few humans are not

affected by. The United Nations released a report on the state of the world's cities in 2011 where they assessed that still in 1950 about 30% of the earth's population was residing in cities, whereas now more than half live in cities, a number expected to reach 80% by 2050.

The British physicist Geoffrey West has even suggested that we call the present time the *Urbanocene* period. This period started after the industrial revolution, which significantly sped up the expansion of cities. He observes: "The future of humanity and long term sustainability of the planet are inextricably linked to the fate of our cities."

We should therefore start preparing for life in cities. But what exactly is so different about cities and what makes life there better? With cities come more opportunities and wealth for its citizens even if this wealth is not evenly distributed. The selection of products, restaurants, entertainment, income, and job opportunities grow with size. The crucial observation demonstrated by the West is that it does not just grow linearly, that is, if you double the number of people, you assume you'd double the number of different types of restaurants, for example. It scales superlinearly with 15% more than would be expected from linear growth. It is simply more exciting to live in cities, and it keeps getting better as it grows. Unfortunately, bad things such as crime, income inequality, disease, and pollution also scale in the same way.

With increases in size also comes an increased need for infrastructure. This is where it gets interesting, for this property does not scale superlinearly, but rather sublinearly. This means that whereas average income increases more than expected from a linear growth model, the costs and needs of roads, pipes, and telephony grow less than would be expected from a linear growth model. Even more strangely, this is 15% less than linear growth, which means that when a city is doubled, we only have to spend 85% more on building and maintaining roads, not 100%.

It seems that there is no turning back from the city as the dominant framework in which we will live our lives in the future. Whether we will ever turn the face of our planet into a planet-wide urban cover like the

fabled city planet of Coruscant from the *Star Wars* movies may be more doubtful, but the future of humanity depends on cities as the framework in which we need to tackle the most important challenges such as pollution, climate change, disease, and crime, but they also provide the possibility to create new ideas, innovation, and use of technology.

We therefore need to reflect on how we develop cities. This is of course not a new thing, and we have been thinking about this and doing it for centuries. The famous French modernist architect and city planner, Le Corbusier, wrote an interesting book, *The City of To-Morrow and Its Planning*, in the start of the previous century in which he summed up two basic approaches to developing the city: “Man walks in a straight line because he has a goal and knows where he is going (..) the pack-donkey meanders along, meditates a little in his scatter brained and distracted fashion, he zigzags in order to avoid larger stones, or to ease the climb, or to gain shade; he takes the line of least resistance.”

The pack donkey becomes the image of the irrational unreflected way of city planning known from the medieval towns, urban sprawl, and slums all over the world. If you have ever admired the winding roads of city centers of Paris, Rome, Zurich, or Copenhagen, you would have experienced the particular charm of a city planned by the way of the pack donkey.

Conversely, the way of man with his straight lines and right angles can be seen in the rational Roman grid-based cities that formed the inspiration for many American cities like New York, Minneapolis, and Lima. These have less of the charm but more efficiency and utility and are definitely easier to find your way in.

While Le Corbusier focused on the physical infrastructure of cities, there is no reason why we cannot generalize the insights to infrastructure in general and technology infrastructure in particular. smart city technology is just another type of infrastructure.

Unfortunately, today most smart city infrastructure is being developed according to the way of the pack donkey in a scatterbrained and distracted

fashion with ad hoc implementations following the path of least resistance. Only rarely are there any grand plans or visions in place to guide the technological infrastructure of the city. Most development is done through scattered pilots, grants, and ad hoc partnerships, inspired by political winds that blew favorably for one particular solution regardless of its merits to the city and its residents.

Le Corbusier had his native Paris in mind and admired the clarity with which Louis XIV built a whole new city of Versailles according to rational principles in order to get away from the Parisian medieval city's chaos. This is a radical way of applying the way of man and will not work in most situations. Fortunately for us and past and present tourists who visit Paris, he also instructed his architect Haussmann to come up with a plan to clean up Paris. This was done by carving out massive boulevards through the medieval center.

Often when we see technology being used at scale in cities, it is more in the fashion of Versailles, a greenfield operation, rather than Haussmann's rational incisions into the heart of the Parisian life. After all, it takes courage and leadership to start to demolish buildings in order to build rational new infrastructure. We probably need both approaches, but we definitely need to start thinking about how technology can help solve the challenges and take advantage of the opportunities in our cities.

This book is about the practical application of technology in order to make our cities more resilient, sustainable, and livable, so that we can approach the middle of the century with a clear conscience and optimism for the future of humanity. Today the use and application of technology has not been sufficiently adopted in our cities. This book is a guide to how we can change that.

The Smart City landscape

The concept of a smart city is not a self-explanatory one. Smart city projects are frequently airy visions fueled by vendor marketing. Mega vendors like IBM, GE, Siemens, Citrix, Samsung, and Hitachi have been banging the drums for a decade, but while their ideas are visionary, there is a huge gap between the ideas and the realization of them.

Some may have heard of futuristic cities like Songdo in South Korea or Masdar in Abu Dhabi. They were envisioned as the smart cities of the future. However, they appear more like greenfield exhibits similar to Versailles than the real-life pulsating cities most people live in and want to live in. They have not been successful in much else than showcasing technology and vendors. Anything we may learn would also be difficult to apply because people live in cities that already exist. It is the exception that we will build a city from scratch.

Reading the literature on smart cities will also baffle most. Some are airy in different more philosophical ways. Consider this quote from the excellent book *The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life*: “Optimization inflected with humanization means neither metropolitan-scale computers nor a network-enabled wild west. It is the convergence of bits and atoms: systems and citizens.” It is hard to decode what it actually means and even more so how this is practically applicable in any real-world sense. How will we make cities, the earth, and humanity better given this insight?

Others are more practical but often end up being a disorganized list of interesting insights and projects from across the world. This is great for inspiration, but little will be learned in terms of generalizable and practically applicable insights. There seems to be no book on the fundamentals and practical application of smart city technology to create more livable, resilient, and prosperous cities.

This book aims to demystify this amorphous concept of the smart city and its implications. In order to do this, we should at least start with some sort of understanding of what we mean by the concept smart city.

To get an idea, let us look at a definition that at least has the virtue of being created by a standardization organization, namely, the International Telecommunication Union (ITU):

“A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects.”

This gives us a good idea about what we want to talk about but is also a bit vague. What, for example, does it precisely mean that a city is innovative? Can a city not be a smart city if it copies all the best solutions from other cities? Similarly, it is difficult to validate whether the needs of future generations are really met. Strictly speaking, we would have to wait generations in order to find out if a city is indeed a smart city.

Rather than getting lost on definitional details, let us focus on what seems to be the core of the smart city. We want to understand how technology can help a city deal with challenges and provide opportunities for its residents so as to make it a more sustainable, resilient, and livable city.

Understanding the smart city is about understanding technology as the crucial component in softening stresses and shocks like disease, crime, and disasters and improving opportunities like employment, choice, and innovation. All of these themes are already being pursued by standard political means such as legislation and taxation and having hospitals and fire and police stations. The crucial part about the smart city is how technology can add to these existing ways a city pursues its goals.

Actors in the Smart City

In order to understand how smart city solutions are developed, implemented, and maintained in practice, we need to consider the actors in a city. We need to understand the interests and goals of different types of actors that make smart city implementations possible or impossible. Even though the end goal of a functioning city may be the same, the motivations, power, and interests are very different. These groups follow very different logics, and a failure to understand this is a cause of many failures of smart city implementations resulting in an inability to harvest the full potential of technology. Consequently, we will spend some time to get acquainted with the different actors in smart city implementations and understand their particular interests and logic.

Individuals

Individuals are the people living, working, or staying in the city, basically the people who come there for one reason or another. Obviously, these individuals are very different and belong to multiple different ethnic and religious groups, but from a smart city perspective, they are fairly similar. We can distinguish three primary groups of individuals that have a different interest in smart cities.

Residents – Are the individuals residing in the city permanently. They are the ones who have their official address registered in the city and are able to take advantage of the city's offerings like benefits and health care and participate in voting. Since they have their day-to-day life in the city, their primary interests are the functioning of the city's services and infrastructure. They are a primary group to keep happy since they are the ones complaining and, in a democratic context, vote for the city's elected officials. If traffic or pollution is too bad, they will move away, and the city will miss their contributions.

Visitors – This is a group that is often missed from smart city discussions, but many cities like New York, London, and Paris have significant economic incentives to keep tourists happy. Tourists don't need access to social services and health care like residents, but they do need mobility and infrastructure like wifi access points, chargers, and such. Another group of visitors are seasonal workers. Their needs are somewhere in between visitors and residents.

Civic activists – Are naturally a subset of residents, but their behavior is very different, because they are not just more or less passive consumers of city services but actively participate in shaping and producing novel smart city solutions.

Businesses

One of the most important actors are businesses as they drive many of the primary functions of a city. Having businesses operate in a city not only creates jobs in those companies and brings in tax revenue to the city; it also creates demand for other businesses and services. Frequently, smart city initiatives start as engagements with the local business community or are conceived as natural extensions of economic development plans. Sometimes this is done through zoning where special areas are reserved for technology experimentations, and at other times, it is done through the city investing in new infrastructure that can be characterized as smart city initiatives.

Vendors

These are the entities actively engaged in developing, deploying, and maintaining smart city solutions. To some extent, they are also impacted by city regulations and governance processes, but for the purposes here, we will focus on them as primarily actively engaged entities and a primary group in materializing smart city solutions.

Hardware vendors – It can be difficult to find pure hardware vendors as software is almost always a part of the product. The business of selling hardware is very different, since the company is rewarded for selling physical units primarily. Their interest is therefore tied to new deployment scenarios in the city. Often the offering comes wrapped with a full software solution, which means that they will try to make money of that too, but in general they will be motivated to sell as many units as possible regardless of whether they will exist in the long term. A special case of hardware vendors is telecommunications providers. Whereas they don't sell their hardware directly, the implementation and use of it is critically tied to cities allowing them to do it and using them for solution deployments.

Software vendors – Only sell their products embedded with hardware in exceptional cases like appliances or when they supply peripheral hardware like AWS and Microsoft offering an Internet of Things (IoT) button. Consequently, these vendors are interested in solutions where their software generates license, support, or subscription fees, which means they are interested in embedding their software in lasting solutions or as is the case with cloud vendors, to become the main platform for any type of solution. This means they are interested in integrating their solutions with other existing solutions to create durable long-term solutions or platforms.

Systems integrators – Are the ones who develop holistic discrete solutions that work from end to end. They are typically working on a project-based contract with a fixed number of deliverables. They are motivated to make the deployment as easy as possible and will often work toward a siloed solution, since it is easier when everything is isolated.

Government

Governments are groups of people authorized to develop and enforce policies in a sovereign area. Typically, it is split into a legislative, executive, and judiciary branch, but that need not be the case. It is also frequently

divided into different layers with different authorities like the national, regional, and local governments.

- **National** – This level is not typically the most important for cities in the United States and Europe. National government may be interested in creating incentives for cities to develop smart city applications. This could be in the form of subsidizing certain types of development, or it could be in the form of grants to study and develop smart city solutions. In Asia, the situation is the reverse. In India and China, the smart city agenda is to a great extent driven from the top down by the national government.
- **Regional** – Many countries have a regional form of government with varying degrees of autonomy. The individual states in the United States or cantons in Switzerland are examples. Like the national government, they are rarely concerned with one particular city unless that city is central in their region, like New York City in the New York state. In this case, there can be a certain degree of interference between the interests at the regional and local levels.
- **Local** – Is the actual city level, which is the most important level for smart cities. The local level of government is directly affected by the successes and failures of smart city initiatives. This means that they are the most motivated to show progress. This, however, is also a case for concern since the mere fact of showing progress in the form of media stories and goodwill can sometimes limit the long-term effects of smart city initiatives.

Researchers

This group is interested in gaining knowledge in general and new insights in particular. Their primary interest is typically in experiments and data. They look for novelty and are rarely concerned with things such as deployment and scalability of solutions. There are a few variants:

- **Universities** – Are still the most prominent research institution since they have it as one of their main goals to do research. They sometimes struggle with the relevance of their research for the wider society. That said, there are different interests based on how universities are involved in smart cities:
 - Providing real-world problems as subject matter for students' projects
 - Internships for students
 - Research opportunities for scientific staff in the form of projects and collaborations
 - Paid research that generates revenue for the university
 - Grants that can help fund labs and staff
- **Private research** – These can be traditional think tanks and will typically have an interest in a particular niche subject. They are often more motivated by political incentives, for example, from special interest groups, than novelty, which is the main driver for universities. Private research typically ends up as reports that are published and promoted in the media.