Smart City

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Foreword

The digital revolution is impacting all sectors of our economy including the public sector, and with it the administration and management of cities. On the one hand, it urges decision-makers to face new challenges, which at times seem insurmountable, but on the other hand it creates a lot of new opportunities for city leaders. Some of these opportunities can be subsumed into the field of "Smart City", a term that describes the improvement or creation of new city services through the use of digital technologies. The topic of Smart Cities has started to appear in many discussions amongst city leaders. What remains unclear, however, is what the drivers and success factors for executing Smart City projects are. City leaders lack a framework or roadmap to help them drive successful Smart City initiatives.

A "Smart City" specific digitization framework

At Swisscom, our mission is to accompany the Swiss economy in its digital transformation, and with it the public sector's city administrations. We think that having a structured approach to identify Smart City projects that efficiently leverage digital technologies, firstly increases significantly the chance of success, and secondly leads to the creation of synergies that bring high cost savings. We therefore have partnered with IMD to develop a framework, the "Smart City Piano", which is specific and tailored to the challenges faced by urban areas.

At the Global Center for Digital Business Transformation, an IMD and Cisco initiative, our objective is to understand the dynamics of digital transformation for public and private sector organizations. We have observed that most city leaders are well aware of the opportunities that digital tools and technologies can provide, but are unclear on how to leverage them. Success requires much more than getting the technology right. It requires a coordinated approach that balances organizational, political, social, and technological factors. With this report, we hope to provide guidance to city leaders on how to make their cities smarter.

With these objectives in mind, we decided to combine the strengths of three experts groups: the academic world, management consultancy and specific project delivery entities. We think that the results presented in this paper have proven this choice to be the right one. Indeed, it not only helped us to approach the problem in an efficient way to achieve meaningful results, but as well to build a framework with the ultimate goal of supporting city leaders in their Smart City journeys.

We are now applying this framework, the Smart City Piano, on specific city cases. Our goal is to support cities along the complete Smart City journey, from the first phase of uncertainty until the successful implementation and operation of ambitious Smart City projects.

Executive summary

This paper presents research into the transformative, principally technological, urban initiatives that are grouped under the heading Smart City projects, and is targeted at city leaders across the globe to help them turn their cities into Smart Cities. We present a concise definition of the term Smart City and explore the four main motivation criteria for engaging in Smart City projects from a city perspective, which include efficiency benefits, environmental objectives, augmenting a city's social inclusiveness, and increasing a city's attractiveness.

The paper presents practical examples of Smart City projects and introduces the Smart City Piano tool. The Smart City Piano can be used to assess the transformation requirements for a city wanting to implement Smart City projects and consists of the following seven distinctive keys: Technology/Infrastructure, Business Case, Politics, Regulations, Governance/Organizational Structure, People Skills and Soft/Cultural Factors. Within each of the seven keys, we have identified a number of factors that will affect the implementation success of a potential Smart City project. Because the keys are closely interrelated and chronologically dependent, we have grouped them into three distinct categories that logically follow each other in sequence, so that they may be played as 'chords'. The three categories are: "Assessing the Potential", "Preparing the Groundwork", and "Managing the Execution".

Smart City projects are both transformative and challenging, and no single operative model or definition has yet emerged; this paper is intended to give a broad view across the field allowing insights into their diverse nature.

Methodology

The study involved the in-depth exploration of twenty-five one-hour interviews with a range of relevant stakeholders from across the world, including Smart City product and service suppliers, and buyers from city organizations and departments.

Small and medium sized cities already on the journey towards becoming 'smart' rarely receive the exposure for their Smart City projects that larger, more well-known cities do. Nevertheless, we believe that the experiences of the small and medium sized cities provide valuable insights, which is the reason we have mainly focused on interviewing those type of cities.

The 25 interviewed cities and enterprises are:

Cities

Baar
Copenhagen
Louisville (KY)
Lyon
Nice
Pittsburgh (PA)
Singapore
South Bend (IN)
Vevey
Vienna
Zurich

SMEs

BH Technologies
Breezometer
Gfeller Informatik Ltd
Libelium
Novaccess
Plair SA
Sensity
Siradel
Tvilight

MNEs

Cisco
IBM
Philips Lighting
Schneider Electric

What is a Smart City?

Smart City has lately become a buzzword for anyone involved in governing a city. Mayors, department officials, even blue collar city employees have heard of the concept and are starting to realize its potential for cities large and small. According to Mordor Intelligence LLP, the global Smart City market size will grow from approximately $390 billion in 2014 to about $1.4 trillion in the year 2020, at a compound annual growth rate (CAGR) of 20.5% over the forecasted period.[1] Transparency Market Research, meanwhile, believes that the global Smart City market size will reach a total market value of $1.3 trillion by 2019, growing at a CAGR of 14% from 2013 to 2019.[2] Other consulting companies such as Frost and Sullivan predict similar market size and growth figures, which leads to the assumption that the predicted economic impact will be substantial.[3]

The term Smart City remains opaque and relatively ill-defined. Several interviewees in our study mentioned that the concept is 'spongy' or 'vague' and that clarification of what it means is needed. According to our research, there is no recognized definition that can unambiguously describe a Smart City in any detail. Academic papers mention the same problem.[4, p. 48] [5, pp. 81–82] [6, p. 25] Currently, the term is used as a catch-all for various different city development initiatives and concepts.

For the purposes of this paper, we therefore propose the following definition of a Smart City:

A Smart City is an urban area that has become more efficient and/or more environmentally friendly and/or more socially inclusive through the use of digital technologies. The goal of a Smart City is to improve its attractiveness to citizens and/or businesses by enhancing or adding city services.

A 'city service' can be anything a city offers to its citizens or businesses, including lighting, traffic management, public parking, electricity, etc. In general, most of the activities a city performs can be classified as city services. It is the improvement or the creation of city services with the help of digital technologies that lets a city become smart in the end. An example of a new city service might be a pollution monitoring application for smartphones that shows real-time pollution within a city, assuming that the city didn't already offer pollution monitoring. An example of an improved city service would be a parking application for smartphones that citizens may use to quickly locate free parking spots in a city, clearly an improved public parking service.
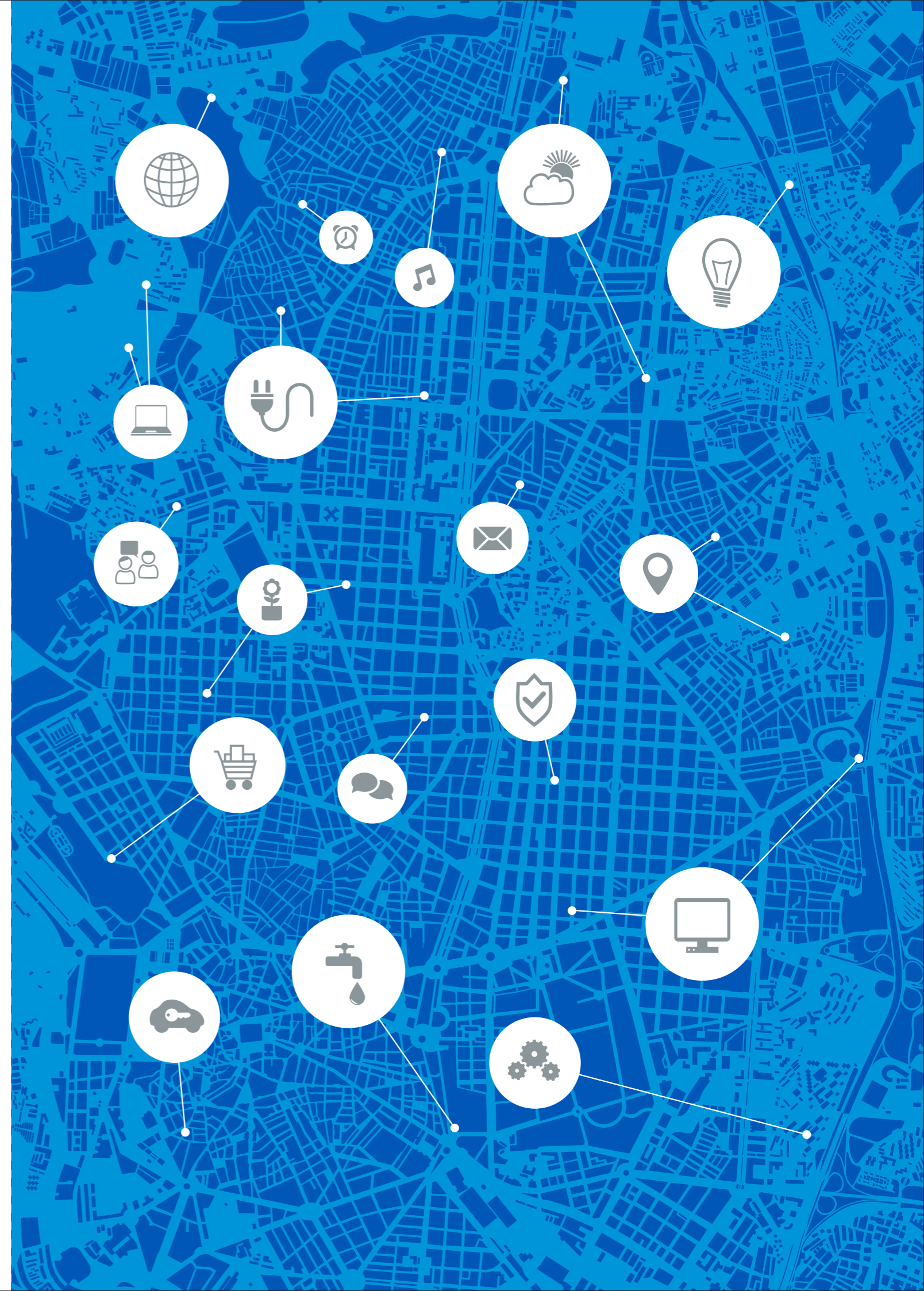
Why become a Smart City?

Through our interviews, we uncovered a multitude of reasons why cities want to become 'smart'. We have grouped these reasons into four broad categories, within which we will present examples of projects that can be executed to become a Smart City.

It is important to note that the range of Smart City projects a city can pursue is enormous, and ever growing. Due to the absence of a universally accepted Smart City definition, quite diverse concepts and use-cases have been filed under the term Smart City with a relatively high degree of freedom. The critical question, however, remains – when does a specific concept or use-case become 'smart'? At what point does the management of lighting, traffic or waste turn into "smart management"? There is at present no definitive answer due to the sponginess of the concept, leaving considerable room for interpretation. Some interviewees stated that a city could never achieve it all; there will always be room for improvement. Alexey Ershov, Vice President of Smarter Cities Europe at IBM replies: "Becoming a Smart City is a continuous process, there is no city who has done it all and has nothing more to do."
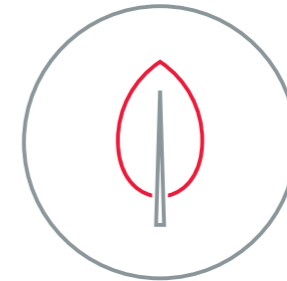
There is a good chance that a given city has already implemented or is currently implementing projects that can be labeled 'smart'.

As a first step, cities might therefore analyze what activities they have already been doing in a particular field.
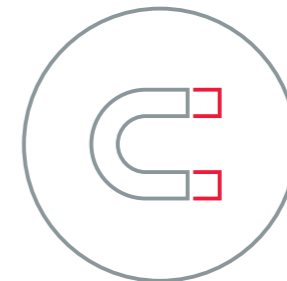
MAIN REASONS FOR BECOMING A SMART CITY:

EFFICIENCY BENEFITS

ENVIRONMENTAL OBJECTIVES

INCREASING SOCIAL INCLUSIVENESS

BECOMING A MORE ATTRACTIVE CITY

Efficiency benefits

Based on insights from our interviews, one of the most cited reasons for initiating Smart City projects is to make a city more efficient. Oftentimes, the ultimate goal is to be able to use a city's infrastructure more efficiently, leading to either cost savings or increased revenues.

For example, a city that implements a smart waste management solution – to collect waste disposal more efficiently – is ultimately able to reduce costs. Smart Waste Management optimizes the emptying of trash bins within a city through the use of sensors installed inside the bins to monitor their individual level of trash. Bins are only emptied when full, and no longer on a standardized schedule regardless of fill level. Trash bins therefore have to be emptied less frequently. A secondary impact of such a project is that fewer waste vehicles are circulating on the streets on average, which reduces traffic congestion. Companies that have implemented smart waste management solutions estimate that savings can be up to 50% of the waste management logistics expenditures, while also reducing the number of kilometers needed to empty the bins by 20%.[7] [8]

Another interesting Smart City project example that makes a city more efficient is Smart Lighting. Smart Lighting aims to reduce electricity consumption through the use of intelligent lighting control, such as dimming lights on streets without pedestrians or traffic. Smart Lighting systems are frequently also equipped with central management software that monitors usage and leads to maintenance efficiency. The city of Szczecin, Poland, has installed a connected Smart Lighting system that allows them to reduce electricity consumption by 50% and overall costs by 70%.[9]

On the other hand, a city that sets up a smart parking solution is usually able to generate higher profits from the same number of parking spaces, as the spaces are used to their full capacity, and the payment system is also more efficient.[10] For instance, the city of Barcelona, Spain, was able to increase its annual parking fee revenues by $50 million following the implementation of a smart parking solution.[11]

Smart City projects can even be used to propel the economic development of a region, which is what the city of Nice, France sought to do within the Smart City sector in 2008. Its strategy was to build the sector through the creation of supporting infrastructure and by providing grants, encouraging sector-specific investment to establish an economic center of excellence. The ultimate goal is to facilitate the creation of 20,000 jobs within 20 years.

Being able to use a city's infrastructure more efficiently, leading to either cost savings or increased revenues.

Environmental objectives

Besides the economic rationale to either save costs or increase revenues, several other reasons were identified in our research as to why cities would like to become 'smart', including a desire to steer the city in a more environmentally friendly direction; to become 'greener'. Projects in this category included initiatives to decrease CO_2 emissions, reduce electricity or water consumption and/or cut down on environmental pollution such as particulate, noise or lighting pollution.

For instance, some cities have ambitious goals to reduce micro-particulate emissions or noise pollution. To ensure that emission levels are actually dropping, a city first needs to be able to measure them. This can be achieved with connected, or even independent, intelligent sensors that measure particulates (or noise) levels in order to compare them with reference and target values. The data can also be made publicly available to citizens through, for instance, a smartphone application. Some cities offer access to allergen monitoring data in a similar fashion. By setting up an environmental monitoring system and providing information to its citizens, a city can make a substantial step towards becoming more environmentally friendly.

The city of Louisville, Kentucky, is a challenging place to live for people with breathing disorders, due to the below-average air quality. By giving away sensors that patients can mount on their asthma inhalers, the city is able to measure where and when inhalers are utilized to prevent an asthma attack. Making the collected data available to asthma sufferers will help them better manage their symptoms and provides support to city leaders in their efforts to get cleaner air.[12]

Another type of project with perhaps surprising environmental benefits is the offering of new flexible forms of work, enabled in combination with trends such as Bring Your Own Device (BYOD), Mobile Collaboration, Telecommuting and Business Travel Avoidance. Swisscom has co-coined the term "Work Smart" for these new types of working arrangements. The idea is simple: Employees should work location-independent and flexible, which is achieved on one hand through the availability of adequate technical equipment for the employees and on the other hand through the required cultural change within the organization. Cities implementing such practices with employees can substantially reduce CO_2 emissions, because employees are able to travel less for work by avoiding physical meeting attendance or by working from home. Moreover, employee productivity rises by about 12% due to the fact that employees can choose to work during their most productive hours, which is not necessarily from 9 to 5 for everyone.[13] [14]
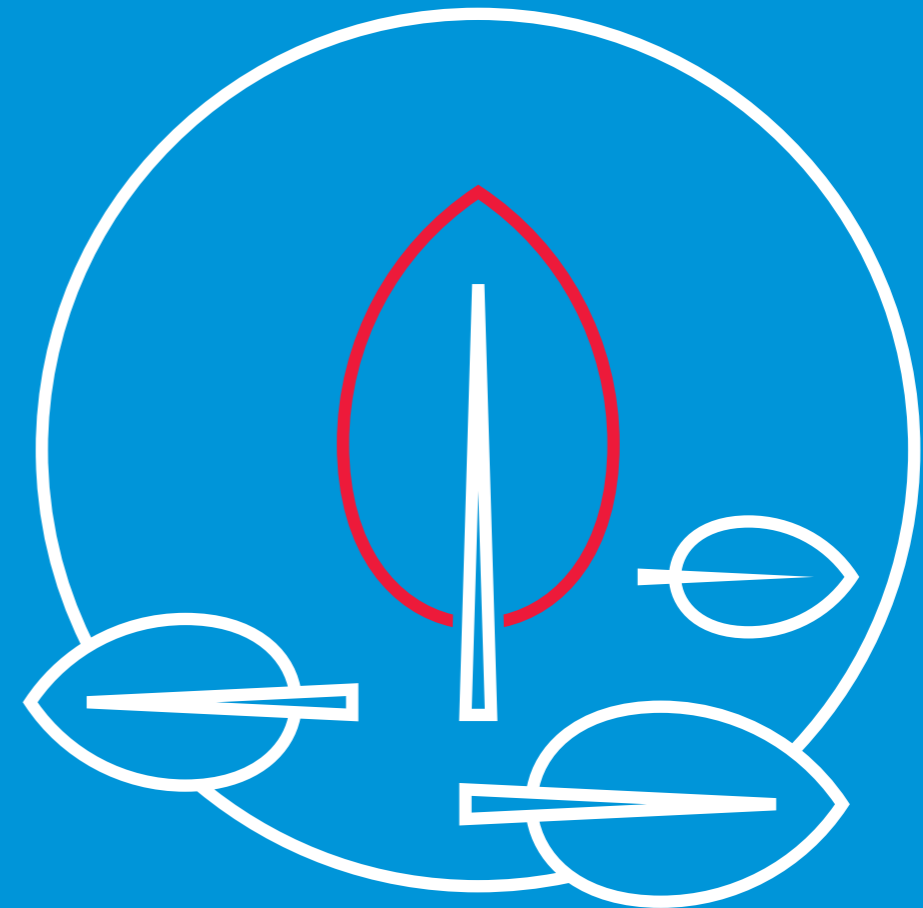
Becoming more environmentally friendly, by reducing CO_2 emissions, reducing energy and water consumption or cutting down environmental pollution.

Increasing social inclusiveness

Furthermore, engaging in Smart City projects can lead to a more socially inclusive city and promote positive interaction between the city and its citizens. In Vienna, the legislature is providing open access to large quantities of data collected within the city. Citizens and businesses can access the data-sets and develop new applications and services based on them.[15] In Nice, for example, members of the public can interact directly with a city employee in a photo-booth like cabin, facilitating a whole host of administrative functions and procedures.[16] Wladimir Boric, Director of Higher Education, Research and New Sectors at Métropole Nice Côte d'Azur, also explained that his city has developed a Smart Metering solution for people living in social housing, giving them the opportunity to check their energy consumption in real time, with the ultimate goal to give them a tool to lower their energy bills in the long run.

Synergies are often possible between different types of Smart City projects. For instance, twenty years ago, the sole task of a lamp pole was to light up the streets in a city. Today, lamp poles can be used to mount pollen, noise or wind sensors, which in turn use the same communication network to transfer data that is required by smart street lamps.

Lamp poles for "Sensing the city":

❯ **Measure pollen**

❯ **Measure noise**

❯ **Measure wind**

❯ **Steer/control traffic**

❯ **Wifi/small GSM cell**

Increasing social inclusiveness of citizens and businesses, for example by promoting interactions between the city and the citizens or supporting the less well-off population.

Becoming a more attractive city

Some cities have also initiated Smart City projects in order to make themselves more attractive to citizens and businesses. For example, the city of Mulhouse, France, analyzed the wind propagation in the city and its effect on pedestrians. The results of the analysis indicated that a scientifically planned tree-planting scheme would act to prevent wind propagation and thus increase the well-being of its citizens.[17]

Additionally, cities often experience difficulties in maintaining businesses in city centers, as they struggle with traffic congestion, poor parking options, and competition from big-box stores. If they can improve the traffic flow within a city through a Smart City project, this will encourage businesses to continue operations in the city itself. Less congested roads will also make the city more attractive to the citizens who live there. Therefore, some cities have initiated Smart Traffic initiatives to predict and optimize traffic flow, as well as traffic and infrastructure planning according to current and future needs. The town of Pully, Switzerland, used Swisscom's anonymized and aggregated mobile big data analysis services to optimize traffic flow in the center of the city and to better plan future infrastructure investments.[18]

Another problem that contributes to traffic overload is navigating around looking for a parking space, which in some cases can substantially increase traffic congestion. Smart Parking solutions display the nearest available parking spaces on a smartphone application, meaning drivers do not have to drive around searching for a free spot. This innovative technology leads to significantly reduced driving time, increases the attractiveness of the city in the eyes of its citizens, and cuts down on traffic congestion. The city of Santander, Spain, for example, was able to reduce downtown traffic congestion by 80 percent thanks to a smart parking application. The city also saw a reduction in travel times and environmental pollution.[19]
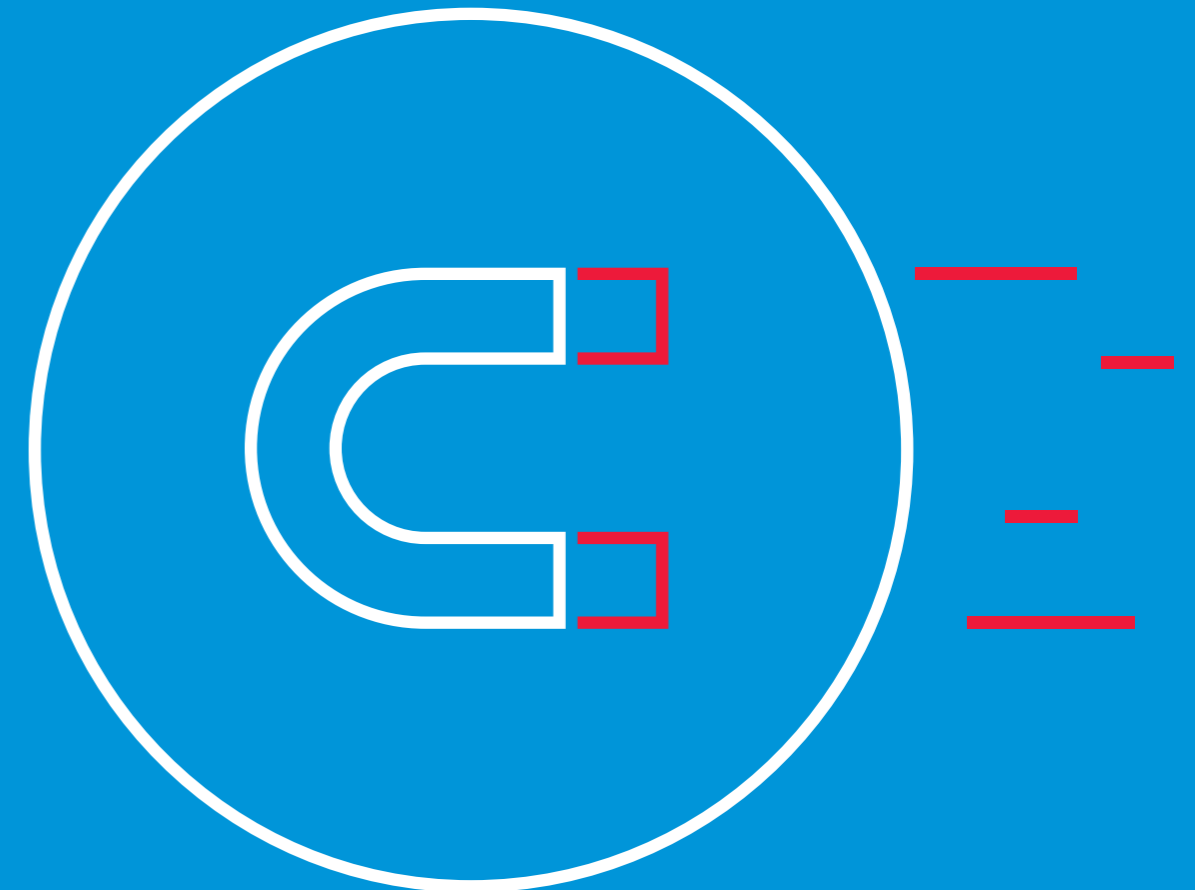
Becoming a more attractive city from the citizens and businesses perspective, for instance by improving the well-being of citizens or improving the conditions for doing business in the city.

The Smart City Piano: Assessing a city's transformation needs

In order to help cities implement Smart City projects, we have developed the so-called Smart City Piano tool. The Smart City Piano defines seven keys that structure what a city needs to do to implement a Smart City project. Within each of the seven keys, we have identified a number of different factors that will impact the implementation success of a potential Smart City project. These success factors have been identified through our qualitative interviews.

The seven Smart City Piano keys are:

- TECHNOLOGY/INFRASTRUCTURE
  What technology/infrastructure do you have to implement?

- BUSINESS CASE
  Can you finance the project?

- POLITICS
  How might politics influence the project?

- REGULATIONS
  How do regulations influence the project?

- GOVERNANCE/ORGANIZATIONAL STRUCTURE
  How will the city's governance and organizational
  structure influence the success of the project?

- PEOPLE SKILLS
  What skills do we need to implement the project?

- SOFT/CULTURAL FACTORS
  What soft and cultural factors might influence the project?
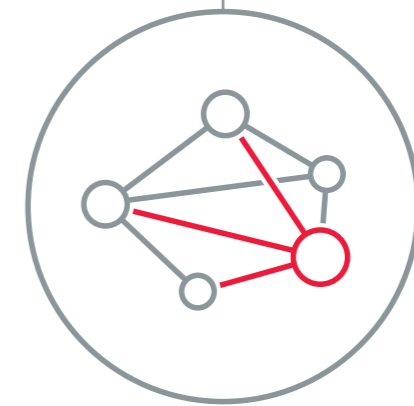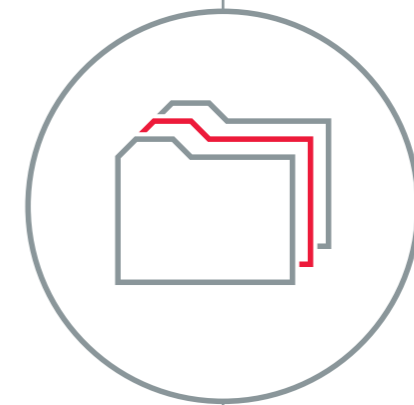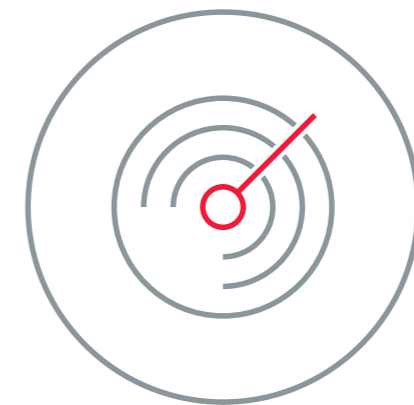
It is important to note that many of the Smart City Piano keys are closely interrelated and chronologically dependent. Therefore, we have grouped the seven keys into three different categories that logically follow each other in sequence so that the keys can be played as 'chords':

ASSESSING THE POTENTIAL

As a first step to assessing the transformation needs of a city that wants to implement a Smart City project, city leaders need to determine which technological solution they would like to implement, consider the corresponding business case, as well as means to finance the project.

PREPARING THE GROUNDWORK

Thereafter, they must prepare the groundwork for executing the Smart City project by assessing the political support and taking into consideration the regulations that might affect the implementation success of the project.

MANAGING THE EXECUTION

Finally, the execution must be managed by assessing what governance and organizational structure that has to be put in place, what people skills are required to successfully execute the project and what cultural/soft factors might influence the success of the Smart City project.
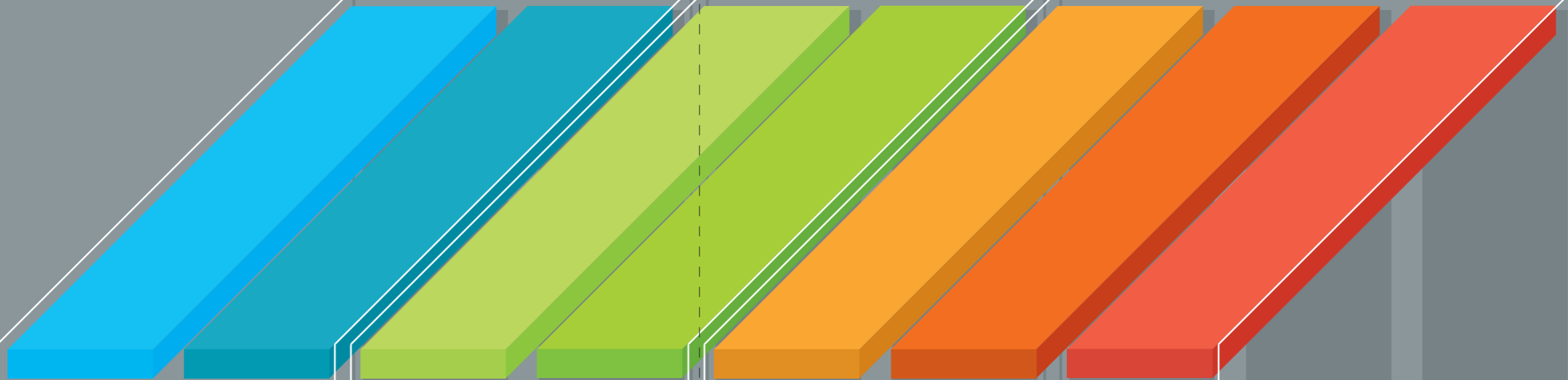
TECHNOLOGY/ INFRASTRUCTURE

BUSINESS CASE

POLITICS

REGULATIONS

GOVERNANCE/ ORGANIZATIONAL STRUCTURE

PEOPLE SKILLS

SOFT/CULTURAL FACTORS

The seven Smart City Piano keys and the corresponding success factors are discussed in more detail on the following pages.

Technology/Infrastructure

Cities have to make sure that they take into account existing infrastructure and technology. Only in rare cases will a city have the financial resources to completely rebuild for instance its entire lighting infrastructure to set up a Smart Lighting solution. Instead, cities usually have to find ways in which the new technology can function in combination with existing systems.

To determine the suitability of new technology in a specific city with given preconditions, a proof of concept of the technology/infrastructure plan is recommended. Working with a prototype not only allows for testing of the technology, but also of whether the relationship between a city and a third-party supplier is optimal. The strength of the collaboration is an important aspect of many projects given that infrastructural investments in a city are normally long-term purchases. Further, a proof of concept can help mobilize people internally in a city. People will get excited if they see that a prototype of a Smart City project works well. Hervé Dedieu, CEO of Novaccess, puts it this way: "You have to work with a proof of concept and this proof of concept serves to put all responsible people at the same table."

Cities should also seek to use open technology standards whenever possible, to avoid single supplier lock-in and to be able to use the technology for other purposes. An important consideration is the clarification of ownership of specific, key infrastructural elements. Sometimes it will be the government (local, regional or national), but it might be city-owned, and infrastructure may even belong to a private company. The question of ownership is important, not only because of its implications for those who finance the project, but also for those who own any additional infrastructural elements (e.g. integrating network nodes into street-lighting). Management of the infrastructure is also an important issue, because the owner and the manager of the infrastructure are not necessarily the same entity. With the use of digital technologies, cities may find it easier to measure the performance of outsourced services.

Success factors for Technology/Infrastructure:

❯ **Leverage existing infrastructure/technology**

❯ **Work with proof of concept**

❯ **Use open standards**

❯ **Clarify ownership and management of technology/infrastructure**

❯ **If you follow an open data approach: Agree on strategy to answer pitfalls**

Open data

Another key trend is the increasing use of open data standards. When a city digitizes city services, a constant stream of data is generally produced. This data can be made publicly available in standardized form, which is called 'open data'. Citizens, startups, multinationals, etc. can then use the data to create new services. For example, the government of Singapore has an open data initiative where seventy public agencies share datasets with the public. As of today, more than one hundred applications have been created using the government's data.[20] Similarly, Nice also takes the view that urban data inherently carry an economic value, which is the reason that they too are providing their urban data to businesses on an open data platform.[21]

However, there can be resistance towards the open data approach within a city from the population itself, if the purpose and benefits are not clearly communicated. People are naturally suspicious of mass publication of data collected about them. Such fears can be minimized through good communication and education regarding the purpose of gathering data and how it will be used, be it their own data or anonymized data. If the population understands both the scope of data gathering and the benefits to them, they are more likely to allow their data to be used.

Thomas Madreiter, Director of Planning at the city of Vienna, adds that transparent processes and a clear positioning of the City Council and the head of city administration in favour of open data may help ease fears about the open data approach. The city of Nice handles concerns from citizens on this issue by discussing the concept of open data in depth on their open data platform through the use of videos and other tools.[22]

There are other pitfalls connected to letting private citizens and businesses create city-specific applications based on publicly available data. First of all, the number of applications may become too large for the city to effectively review – leading to poor quality control. Second, there's the question of application ownership and support; if an app developer goes bankrupt or relocates elsewhere, it may not be possible to continue offering the service. This is especially problematic if the application is perceived as a public service. Third, there may be issues with the security of the applications and any subsequent reuse of the data – proper governance of any third-party applications and services is a critical factor.

Business Case

During our research we have identified three types of business cases that prevail in the Smart City field. The first type of business case includes Smart City projects that will lead to some form of additional revenues for a city, such as Smart Parking. As mentioned previously, Barcelona has been able to increase its annual parking fee revenues by $50 million by introducing a Smart Parking solution.[11]

The second type of business case involves Smart City projects that will lead to cost savings. Examples of Smart City project types might be Smart Lighting or Smart Waste Management. Typically, these types of projects will generate cost savings from reduced electricity usage, as well as reduced operational, maintenance or logistics costs. They will not normally generate higher revenues.

Within the third type of business case, we find Smart City projects that will not generate either higher revenues or lower costs directly, but simply cause a negative cash outflow. Good examples of such Smart City project types are Video Surveillance and Pollution Monitoring in a city. Such project types do not typically generate either increased revenues or cost savings, because the benefits attributed to such Smart City projects are hard to quantify. For instance, it is difficult to measure how many additional taxpayers you are able to attract because of your city's cleaner air due to pollution monitoring, or improved safety due to video surveillance. But even for the first two types of Smart City business cases, it can be difficult to demonstrate positive revenue gains or cost savings. Energy savings are usually easier to calculate, while operational or logistical savings are much harder to calculate on purely financial terms. Nevertheless, we recommend quantifying as many numbers as possible. Quantifying savings or revenues will help cities to identify benefits that had not previously been considered, and it also provides ammunition to defend Smart City projects when dealing with project committees or politicians.

Given the difficulty of assessing the financial viability of specific projects, it is certainly worth trawling available research for similar projects from other cities, e.g., illustrating the financial viability of a video surveillance project in an urban area. A private sector partner can often be an excellent resource in generating the cost-benefit analysis, and comparing the expected savings/revenues estimates from several bidders can also be helpful when choosing the right approach for a Smart City investment.

Another way to improve the business case for a Smart City project is to consider how to leverage the technology deployed across different Smart City projects. For instance, it might prove to be more cost effective to build one communication network to be used by different Smart City projects than building one network for each project.

Success factors for Business Case:

❯ **Type of business case: Additional revenues, cost savings or cash outflow**

❯ **Quantify as much in numbers as possible**

❯ **Leverage network technology across different Smart City projects**

❯ **Ensure financing of the project**
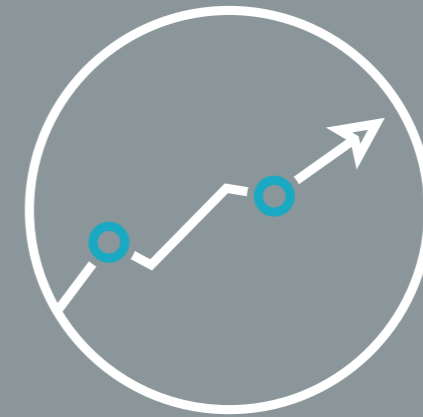
Financing of Smart City projects

Cities also have to ask themselves how they will finance Smart City projects, as their budgets rarely allow for multi-million dollar ventures. One possibility is to lease the infrastructure – moving from a capital expenditure model (CAPEX) to an operational expenditure model (OPEX). This removes, or substantially reduces, the up-front investment needed and the recurring expenditure can be planned across specific city budgets centers. The Smart Lighting example discussed earlier is another way in which expenditures can be lowered, if the supplier installs the infrastructure (in this case the actual street lamps) and the city pays a percentage of its savings on energy costs to the company on an agreed timescale. A secondary advantage of such models is the avoidance of budgetary caps. In some cities, when an investment exceeds a certain amount, a governance body must accept the budgetary expenditure plan, which in the end creates an additional hurdle for projects.

Another model of financing can involve credit funding from banks – repaid with intended cost-savings that flow from Smart City projects and public-private partnership approaches.

Where projects cross departmental boundaries a number of additional key factors should be considered when evaluating the financing model:

• Do all associated revenues accrue evenly to responsible departments, and does each department pay a defined amount of the costs accordingly?

• Is there departmental buy-in – i.e., do other departments support the Smart City project? A good strategy is to identify the benefits (financial, non-financial) of the proposed Smart City project for other departments to get their buy-in and increase the budget.

The financial strength of a city or department plays an important role in determining which projects can be implemented. Big metropolitan cities obviously have bigger budgets, and the total costs of a Smart City project are often only a drop in the bucket. The Police Department of Toronto on its own, for instance, had an annual budget of about $1 billion CAD (or $1.3 billion USD) for 2015.[23] On the other hand, a tight budget can also serve as a useful constraint for a cash-strapped small- or medium-sized city, allowing it to focus more intently on their priorities, and be creative with the available resources. Some of the most groundbreaking case studies we researched sprung out of great need and limited resources.

Smart City projects may also be funded through philanthropy. Generating money from private organizations such as funds, trusts or sponsors could be a viable alternative if city budgets are too tight to allow implementation of a Smart City project. Philanthropy is also an option when a Smart City initiative does not have wide citizen appeal due to risk or novelty, rendering it politically difficult to apply tax money.

Politics

In many cases Smart City projects will depend on governmental support in order to get funding and resources allocated. It is therefore crucial that the Smart City project has the support of the political leaders of a city to ensure success. The city of Copenhagen, Denmark, for instance, received support through a socio-economic analysis, where they asked universities or research faculties with specific knowledge in the field of Smart City to comment on their Smart City initiative and ensure their interest in collaboration. Pully, Switzerland, also experienced a strong push from the political side to engage in a Smart City project with Swisscom to optimize the traffic flow in the center of the city.

In other cases, political agendas can lead to resistance. Mike Hughes, Executive Vice President of Segments and Strategic Customers at Schneider Electric, puts it this way: "Political willingness is influenced by cost, think also about opportunity costs, citizen demand, the own political agenda and as well cyber security."

Some cities work to put in place a dedicated Smart City strategy or policy that is politically legitimate. Such a strategy can provide the guiding principles on how to engage in Smart City projects and further protect ongoing Smart City projects from political turmoil.

Regulations

Cities have to consider whether local, regional or national regulations will affect the implementation of Smart City projects. For example, it might be the case that regulations will not allow a public lighting operator to also manage parking. Project leaders, and potentially the city leadership itself, will then have to decide how to react to what are essentially regulatory hurdles. Does it make sense to change the regulations? If so, can that be achieved within the planned project timescale? Or can the project be implemented in a way that will make it compliant with regulations? Regulatory hurdles are often not the result of specific "anti-smart city" legislation, but tend to be a side effect of legislation that had an entirely separate purpose. The cross-departmental nature of Smart City projects has a tendency to reveal such issues.

Success factors for Politics:
❯ **Ensure political support**
❯ **Manage political resistance**
❯ **Keep in mind setting up/promoting a city-wide Smart City strategy**

Success factors for Regulations:
❯ **Identify regulations that affect the project**
❯ **Mitigate regulation hurdles**

Governance/Organizational Structure

Several cities noted the benefits of decentralizing project ownership and delegating individual Smart City projects to department level. City departments should have a high degree of freedom as to how they want to implement a project; however, they need to have an imperative to fulfill the project through a mayor's decision or a strategic plan. Thomas Madreiter comments: "It is important to decentralize Smart City activities, because activities are more robust and flexible than a centralized system, we simply set the general framework, the Smart City strategy, but we do not interfere in the details."

However, although advocating for the decentralization of Smart City projects on a day-to-day management level, interviewees also cited the importance of having strong top-down governance, due principally to the need to limit the stagnating effect of internal debate and discussions. Vienna has in place a control group headed by the CEO of the city administration to provide the general framework and guidelines for Smart City projects. Søren Kvist, Chief Advisor, Copenhagen Solutions Lab, mentions: "Copenhagen ensures the top down imperative through a regularly scheduled meeting that is held every 6 weeks, where the department officials from the 7 administrations meet to organize the governance, which is important that it happens on a regular basis. Otherwise there will be endless debates and discussions and no truly holistic smart city projects."

City departments are often not used to working with each other across departments, and cross-departmental Smart City projects may therefore be demanding. To mitigate this problem and facilitate Smart City project implementation, many of the interviewees recommended creating projects teams consisting of all relevant stakeholders. Peter Gfeller, owner and CEO of Gfeller Informatik Inc., even suggested that it might be a good idea for cities to receive external support from someone with technical and Smart City context know-how. Jérôme Degryse, CEO of BH Technologies, has his own vision of the organizational setup and role of such a project team: "A good practice would be to put a project team in place that is solely dedicated to Smart City initiatives with a dedicated project manager, this project team would be reporting directly to a head of a department and be under the responsibility of an influential politician." Alicia Asìn, Co-founder and CEO of Libelium, thinks that technical project teams are the ones that can outlast political change.

How many departments a city wants or needs to include when planning projects should be carefully considered, given that cross-departmental projects are often rare and unusual. Our research suggests that reducing cross-departmental complexity by involving fewer departments may make a project easier to complete.

Further, our research insights lead to the conclusion that project teams should be put at the edge of the city/departmental organization to allow them to develop projects and launch pilots in an agile and unencumbered way. In support of this, Søren Kvist argues that the best environment to think out of the box and come up with new solutions is often at the edge of the organization, to foster the collaboration with research institutions and companies and to come up with new solutions that challenge the status quo of doing business.

Cities should also consider the potential for Public-Private Partnerships (PPP) when planning to set up Smart City projects, as a private entity could provide the cutting edge know-how that cities often do not have access to within their own organization. In this context, privacy issues should first be examined. Would citizens be willing to accept that a city leader fully outsources ownership of city services and data to a company like Google? A PPP might be a good possibility if the answer to such a question is no. Ted Smith, Chief Innovation Officer at the city of Louisville and Executive Director at the Institute for Healthy Air, Water, and Soil, states that a PPP might help survive political cycles: "Setting up a PPP and getting it running outside of the government's departments can survive political cycles, and it is even better if citizens expect the government to continue the projects. That leads little room for politicians to stop the project."

Success factors for Governance/ Organizational Structure:

❯ **Decentralization of project ownership**

❯ **Have a strong project governance**

❯ **Set up a cross-departmental project team**

❯ **Put project team at the edge of the organization**

❯ **Consider setting up a Public-Private Partnership**

People Skills

To implement successful Smart City projects, cities must have the right people with the right competencies and experience available – either in-house or externally recruited. The nature of a project should determine the skills required, with cities subsequently auditing existing skillsets within their organization. Where competency gaps are identified, cities can consider either training existing employees, or hiring new staff. Sometimes it may be appropriate to hire employees on a flexible, project-by-project basis. Søren Kvist explains: "You have to analyze what people skills you need to get Smart City initiatives done. It is important to have a good understanding about the work that has to be undertaken in order to take the right decisions."

From Big Data to Smart Data

Through the use of digital technologies, urban areas are able to generate large amounts of data, so called Big Data. Therefore, cities need to hire employees that have expertise in data science to valorize this enormous data stream by turning it into Smart Data, which is data that has been interpreted and put into context. In addition, to provide its data to third parties, a city needs technical and legal expertise to package and format its data for further utilization.

Success factors for People Skills:
❭ **Determine the skillset needed**
❭ **Perform an internal skillset analysis**
❭ **Mitigate the skill gap**

Soft/Cultural Factors

The ability to successfully implement Smart City projects depends greatly on soft and cultural factors within a city administration. City leaders should think about what work culture they need in order to successfully implement Smart City projects, and how they want to set up leadership and communication.

The insights from our research suggest that an open culture, in which public institutions collaborate with private entities and educational institutions such as universities, is beneficial when setting up Smart City projects. Universities and private enterprises are often on the cutting edge of technology and innovation; therefore, it makes sense for a city to seek their involvement in the Smart City area.

Communication around a Smart City project, both internally towards own employees and externally towards citizens, is important for both acceptance and success. Communication to the local population is a key aspect. Citizen support is crucial for the success of Smart City initiatives that affect them directly, such as Smart Parking, and it is important to establish a two-way communication channel, interacting closely with citizens throughout the lifecycle of a project for input through consultations. For example, Nice conducts workshops with citizens on a regular basis to gather feedback about new services the city wants to introduce. However, engagement with citizens might be challenging too, because citizens do not necessarily have the technical knowledge about what is theoretically possible in terms of solution.

Cities not only need good external communication, they must also ensure excellent internal communication, to avoid resistance that may hinder the success of a Smart City project. Ted Smith suggests seeking out opponents and involving those people in the project plans to attempt to resolve issues.

In addition to good communication, it is vital to have city leaders who view change positively and are in favor of the project. Several interviewees mention the importance of having strong internal leadership. Sean Harrington, Chief Operating Officer of Sensity, states: "Leadership within a city that wants to set up a Smart City project is crucial. It is ideally a senior person like a CIO or someone who works for the mayor. Further, they need to have authority and tap into several budgets of the departments." Similarly, Dr. Yves Lostanlen, CEO of Siradel North America, agrees that cities need leaders who favor change, are in support of a Smart City project and internally well connected to all the various city departments. However, the change agent and catalyst of a Smart City project is not necessarily the head of a department, but someone who people trust and who can get other people involved in the project. According to Wladimir Boric: "For Smart City projects, you need strong political approval to facilitate finding good project leaders who are team facilitators and who are able to motivate the rest of the city organization."

Success factors for Soft/Cultural Factors:

❯ **Establish an open organizational culture**

❯ **Establish good internal and external communication**

❯ **Deal with resistance from citizens and employees**

❯ **Ensure strong (project) leadership**

Thomas Madreiter, Director of Planning at the city of Vienna, proposed six criteria for the Soft/Cultural Factors key that he deemed crucial for implementing Smart City projects successfully:

1. **City-wide support for engaging in Smart City projects**

2. **Curiosity**

3. **Project team enthusiasm**

4. **Willingness to include partners**

5. **Strong focus on internal and external communication**

6. **Having a strong leader who allows the team to be innovative, who allows others to "win", and who is willing to share success with other teams or departments**

First steps for city leaders

We asked a number of city leaders about their first steps towards becoming a Smart City, and found that they varied greatly from city to city. Some cities, such as Copenhagen, started by identifying challenges and problems, then identified specific projects to ease those issues. Other cities, like Vienna, first set up a Smart City framework strategy, before identifying initiatives aimed at fulfilling strategic objectives.

Based on the first steps reported by these cities, as well as those that they have recommended for other cities, we have compiled a framework which we present in a separate paper "Smart City: A Framework to Take the Concept to the Pavement" on how city leaders can start their cities on the Smart City journey, enabling them to identify Smart City projects, assess the feasibility of each project and the orchestration of multiple Smart City projects.[24]
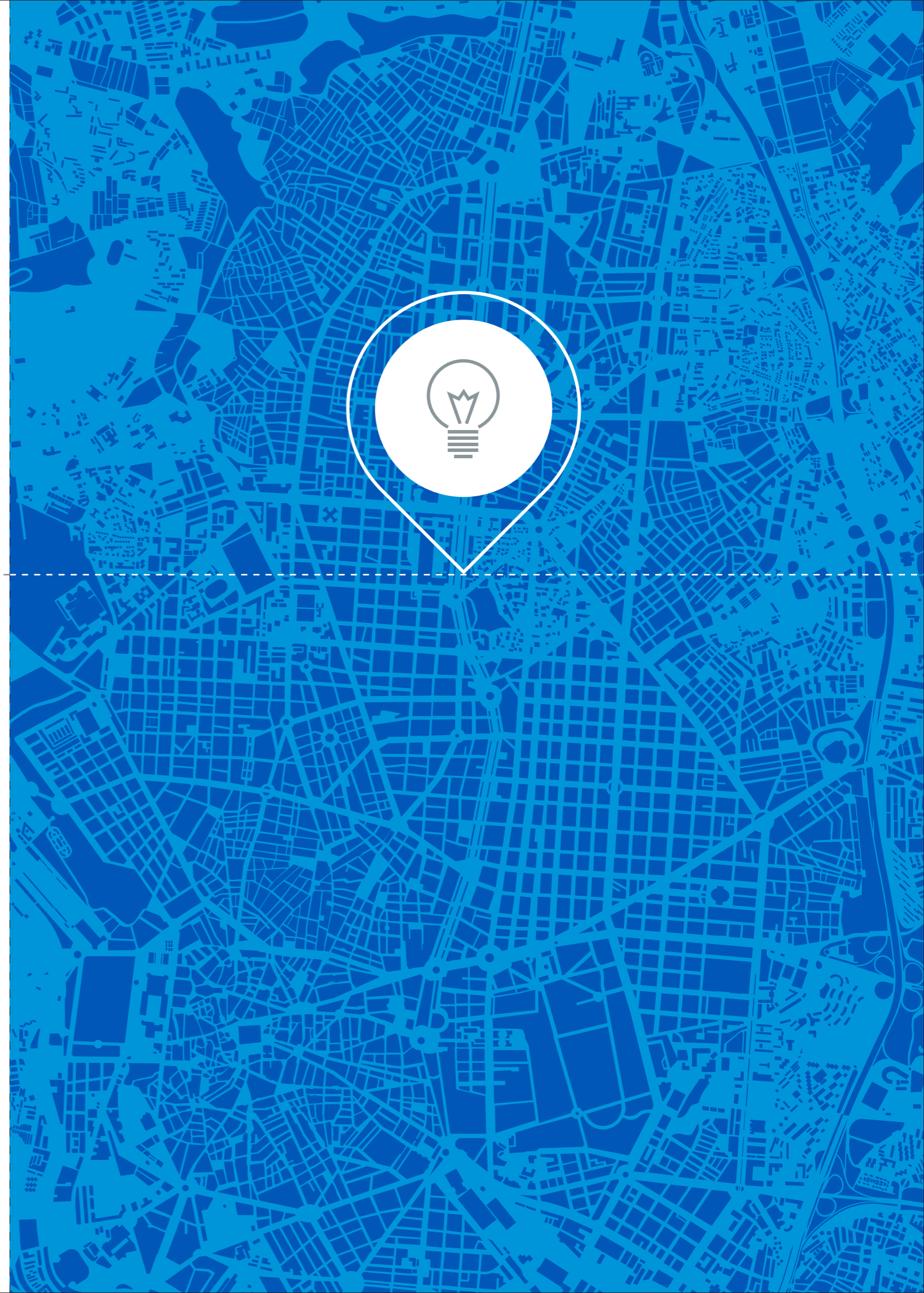
Conclusion

In this report, based on twenty-five one-hour interviews with relevant Smart City stakeholders, we have presented a concise and practical definition of the term Smart City and explored the main motivations for city leaders engaging in Smart City projects, including efficiency benefits, environmental objectives, augmenting a city's social inclusiveness and increasing a city's attractiveness. Additionally, we have introduced the Smart City Piano, which can be used to assess the transformation needs of a city to implement Smart City projects.

The Smart City Piano consists of the following seven keys: Technology/Infrastructure, Business Case, Politics, Regulations, Governance/Organizational Structure, People Skills and Soft/Cultural Factors. For each of the seven keys, we have identified a number of factors that will affect the implementation success of a potential Smart City project. Because several of the seven Smart City Piano keys are closely interrelated and chronologically dependent, it is important to play them as 'chords'. Our sequential categorization of the seven keys addresses this issue and should support city leaders in the assessment of their city's transformation needs.
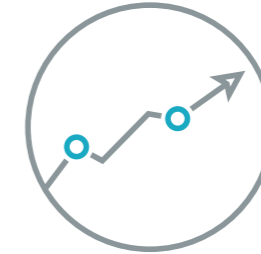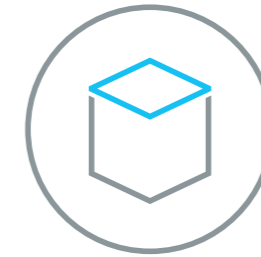
Author biographies

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Michel Peter Pfaeffli is a management consultant in the Enterprise Customers division of Swisscom. Michel is the lead researcher of the present paper and has been actively working as external research associate at IMD for the past eight months. Before working at Swisscom, Michel has obtained a Master in Management with specialization in strategy from HEC Lausanne, one of the leading Swiss business schools. Michel holds as well a bachelor's degree in business administration from the University of Berne. He has worked and studied in 3 countries and currently lives in Switzerland.

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Raphael Rollier currently leads the Smart City Program at Swisscom, creating innovative solutions for public goods based on Internet of Things and Big Data. He has also developed a Mentoring Program for startups at EPFL, he is a jury member at Venture Kick and a Venture Associate at Swisscom. Prior to that, Raphael has been consulting companies in their digital strategy such as connected car in the insurance sector. Raphael Rollier also has 13 years of international marketing & sales and general management experience, having worked for Nokia. He holds a master degree in microengineering from EPFL.

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Michael Wade

Michael Wade is the Cisco Chair in Digital Business Transformation and Professor of Innovation and Strategy at IMD, a Swiss-based business school focusing on executive education. He is the Director of the Global Center for Digital Business Transformation, an IMD and Cisco initiative. Michael Wade has more than 50 articles and presentations to his credit in leading academic journals and conferences and has written 7 books and more than 20 case studies based on his experience working with organizations. He co-Direct's IMD's Leading Digital Business Transformation executive program, and has designed several customized programs for companies such as Credit Suisse, Vodafone, Maersk, Zurich Financial, PSA Peugeot Citroen, and Cartier. He has provided consulting services, executive education, and expert evaluations to public and private sector organizations, including IBM, LVMH, Nestlé, Google, and Novartis. Michael Wade obtained Honours BA, MBA and PhD degrees from the Richard Ivey School of Business, University of Western Ontario, Canada. He has lived and worked in 7 countries and currently resides with his family in Switzerland.

Appendix

City	Name of interviewee	Interviewee position
Baar, Switzerland	Paul Langenegger	Vice-mayor, Director of Construction at the City of Baar
Copenhagen, Denmark	Søren Kvist	Chief Advisor Copenhagen Solutions Lab at the City of Copenhagen
Louisville (KY), U.S.	Ted Smith	Chief Innovation Officer at the City of Louisville and Executive Director at the Institute for Healthy Air, Water, and Soil
Lyon, France	Diana Diziain	Freight & Logistics Project Manager at Lyon Metropolis, Vice Director at Afilog
Nice, France	Wladimir Boric	Director of Higher Education, Research and New Sectors at Métropole Nice Côte d'Azur
Pittsburgh (PA), U.S.	Debra Lam	Chief Innovation & Performance Officer at the City of Pittsburgh
Singapore	Robert De Souza	Executive Director / CEO at The Logistics Institute - Asia Pacific
South Bend (IN), U.S.	Scott Ford	Executive Director, Department of Community Investment at the City of South Bend
Vevey, Switzerland	Daniel Gnerre	Head of Geographic Information System at the City of Vevey, Vice President of ASIT VD
Vienna, Austria	Thomas Madreiter	Director of Planning at the City of Vienna
Zurich, Switzerland	Simon Kuhn	Head of Networks & Operation at ewz Telecom

SME	Name of interviewee	Interviewee position
BH Technologies	Jérôme Degryse	Chief Executive Officer
Breezometer	Ziv Lautman	Co-Founder & Chief Marketing Officer
Gfeller Informatik Inc.	Peter Gfeller	Owner & Chief Executive Officer
Libelium	Alicia Asín	Co-Founder & Chief Executive Officer
Novacess	Hervé Dedieu	Chief Executive Officer
Plair SA	Svetlana Afonina	Co-Founder & Chief Marketing Officer
Sensity Systems	Sean Harrington	Chief Operating Officer
Siradel	Yves Lostanlen	Chief Executive Officer of Siradel North America
Tvilight	Chintan Shah	Chief Executive Officer

MNE	Name of interviewee	Interviewee position
Cisco	Robert Pepper	Vice President, Global Technology Policy
IBM	Alexey Ershov	Vice President, Smarter Cities Europe
IBM	Nicola Villa	Partner and Global Leader, Big Data & Analytics, Public Sector
Philips Lighting	Jeff Cassis	SVP Global Lighting Systems
Schneider Electric	Mike Hughes	Executive Vice President. Segments and Strategic Customers

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