



SMART SOLUTIONS: Technology Serving Communities



ICMA, the International City/County Management Association, advances professional local government through leadership, management, innovation, and ethics. ICMA provides member support, publications, data, and information; peer and results-oriented assistance; and training and professional development to more than 10,000 city, town, and country experts and other individuals and organizations throughout the world. The management decisions made by ICMA's members affect 185 million individuals living in thousands of communities, from small villages and towns to large metropolitan areas.

IBTS, the Institute for Building Technology and Safety— a 501(c)(3) nonprofit organization, delivers regulatory, program management, and technical services to all levels of government. IBTS uses its expertise in the areas of building and community development, energy and sustainability, disaster planning and recovery, building department services, and quality assurance to assist communities in measurable ways. Through collaborative public nonprofit partnerships IBTS generates substantial savings in time and cost with uncompromising quality. IBTS's engagement in the expanding smart cities arena and contributions to this publication are a natural extension of our 40-year track record of identifying, exploring, and communicating topics that contribute to public service excellence.

Smart Solutions: Technology Serving Communities was made possible through the generous financial support of IBTS and contributions of its staff.

Copyright © 2017 International City/County Management Association, 777 North Capitol Street, N.E., Suite 500, Washington, D.C. 20002. All rights reserved, including rights of reproduction and use in any form or by any means, including the making of copies by any photographic process or by any electronic or mechanical device, printed or written or oral, or recoding for sound or visual reproduction, or for use in any knowledge or retrieval system or device, unless permission in writing is obtained from copyright owner.

Item number: e-44070

ISBN 978-0-87326-432-7

Cited Internet sources were valid as of May 2017. Because URLs and websites are constantly changing, we cannot vouch for their current validity.

To locate other ICMA print and digital publications, please visit icma.org/publications-research

Contents

Preface	5
A Roadmap: How to Use This Book	5
Chapter 1: Overview	7
Challenges of Urbanization	7
Improving Managerial Decision Making.....	7
Smart Cities Definitions	8
Technology Innovations Enabling Smart Cities.....	8
Keeping the End in Mind: Smart Visions and Leadership.....	9
An Innovative Environment Supports Smart Cities	9
A Roadmap for Technology Deployment.....	10
Benefits of Being a Smart Community	10
Human Values in Smart Communities	11
Barriers to Smart Communities	11
A Future of Empowered, Connected Smart Citizens.....	11
Endnotes.....	12
Chapter 2: Understanding the Role of Local Government Leaders	13
Vision	13
Planning.....	14
Leadership	15
Collaboration.....	15
Commitment.....	16
Ethics.....	17
Sidebar: Small Communities Leading the Way.....	16
Chapter 3: Getting Started	18
1. What Issue or Problem Are You Trying to Address with New Technology?	18
2. What Are Your Current Capabilities and Gaps?	18
3. What Functionality Is Must-Have Core, and What Is Optional?.....	19
4. Who's Already Doing What It Is You Want to Implement?.....	20
5. What Is the Regulatory and Technology Environment?	20
6. Does What You're Proposing Fit the Organizational or Community Culture?	20
7. How Are You Going to Measure Success?	21
8. Who Needs to Be Involved?	23
9. Who's Paying for All This?	24

Chapter 4: Developing a Sound Process 26
 How Will the Effort Be Overseen, Implemented, Integrated Across Departments and Sectors, and Communicated?.....26
 How Will Governance and Goals Be Defined?27
 How Will the Plan Be Integrated into the Budget and Updated?28
 How Will the Effort Be Evaluated and Results Shared?28
 How and When Will the Lessons Learned Be Documented?29
 Next Steps.....29
 Sidebar: Smart City Priorities Vs. Smart City Engagements.....27

Chapter 5: Smart Cities Case Studies..... 30
 City of Coral Gables, Florida.....31
 City of Olathe, Kansas.....36
 Summit County, Utah39
 City of Bellevue, Washington.....43
 City of Sandy Springs, Georgia46
 City of Boulder, Colorado50
 City of Guymon, Oklahoma.....54
 City of Edmonton, Alberta, Canada.....58
 City of Santa Fe, New Mexico61
 City of Chattanooga, Tennessee64
 City of Dover, New Hampshire.....69
 City of Jacksonville, North Carolina.....73
 City of San Diego, California.....76

Chapter 6: Asking Smart Questions 80
 Smart Leadership80
 Conditions Fostering Smart Solutions.....80
 Impediments to Smart Cities.....81
 Smart Cities Use Data.....81
 Smart Cities, Smart Citizens.....82
 It’s a Smart World After All.....82
 Smart Questions.....82
 Final Thoughts on Smart Technology and Leadership.....83
 Endnotes.....84

Appendix A: Technologies to Watch 85
 Sidebar: Smart City Collaboration: Dublin, Ohio, Demonstration Project.....86

Appendix B: Smart Cities Resources 89

Contributors..... 93

Preface

Communities—cities and counties working with their residents and employees and the private sector—are increasingly deploying smart technologies into their operational systems each day with little fanfare, coordination, or awareness of the impact these technologies have on their civic cultures. *Technology in Western Civilization*, a book on the evolution and impact of technology, notes that

“What distinguishes our age from the past is first our belated recognition of the significance of technology in human affairs; second is the accelerated pace of technological development that makes it part and parcel of our daily living in ever-increasing measure; and third, the realization that technology is not simply a limited or local factor but encompasses all of mankind everywhere and is related to all human endeavors.”¹

With publication of ***Smart Solutions: Technology Serving Communities***, we encourage public administrators to become more familiar with the trends in smart technologies and consider the possibilities, challenges, and impacts of smart technology solutions in their communities. This publication is written for public administrators, elected officials, and academics who desire a primer on “smart cities,” or emerging technologies. ICMA and the Institute for Building Technology and Safety (IBTS) offer *Smart Solutions* in a format featuring pertinent context, how-to guidance, diverse case studies, and relevant resource information on emerging technologies. *Smart Solutions* is intended to encourage further exploration.

This e-book is about “smart cities.” While we use the generic phrase “smart cities,” we write with the awareness that smart communities include both cities and counties and many special-purpose or regional districts. And we recognize that smart cities demonstrate how the appropriate use of technology in our communities can provide solutions and expand the capacities of our communities to better the lives of our residents and visitors.

Sensor-driven automatic smart grids, autonomous or flying vehicles, intelligent customer service analytical platforms, and genetically encoded new plant species for nutritional or medical purposes may all be considered outcomes of smart technology. These examples bring home that point that smart technology is not a distant ship on the horizon; this

ship has arrived in many of your communities, and its crew of advocates is already on “shore leave” in your organizations and communities today.

Smart technologies, when integrated with data analytics platforms and networked into smart community grids, offer the potential of expanding the fundamental capacity of local governments. For the first time in many workplaces, this is occurring in a demographically more complex workforce, with five generations employed at once, each with technological capabilities, preferences, and practical user knowledge not shared by all coworkers. And like other contemporary issues, often leadership in technology change can originate from employees or citizens in the form of a new lexicon—as “hack-a-thons” and “bring your own devices” demonstrate.

Public administrators are undoubtedly at the forefront of decisions about resource allocation and technology deployments in their communities. We know that readers of *Smart Solutions: Technology Serving Communities* will have a leading role in determining how smart technology will affect the future of their communities and lives of citizens. Our hope is that you find *Smart Solutions* a thought-provoking and informative primer for becoming a well-informed leader of smarter communities and for further exploring the possibilities.

A Roadmap: How to Use This Book

Smart Solutions: Technology Serving Communities has been designed as a reference tool for local government professionals considering implementing a “smart communities” approach, using technology to achieve greater efficiency and improved service delivery.

Local governments have much to win in exploring how they can take full advantage of data and technology in their daily operations. For example, as new software applications have come online, local governments have moved from sending field crews out with paper forms, which can be damaged or lost quite easily, to using pads and smartphones to collect data while in the field. Not only is the data more secure, but city hall staff have access to near real-time data for their jobs.

The structure of this book is designed to let you either follow the path as set forward in the table of contents or

“enter” the book at any subject matter point about which you are curious. The intention is to answer important questions local government professionals have about how a smart communities approach will benefit their community.

Smart Solutions: Technology Serving Communities also intentionally stimulates the development of new questions to help move the smart community discussion forward. Local governments have long collected and maintained community-related data, but are still learning how data and technology can be used to achieve greater innovation and realize better results in their work.

In the **Preface**, we introduce the idea of a “smart community” and highlight how that concept works at the community level.

Chapter 1. Overview looks at the history and background of how the “smart community” movement began and where it’s headed.

Chapter 2. Roles highlights the role(s) that need to be fulfilled in developing and designing an effective smart community.

Chapter 3. Getting Started helps local government professionals begin thinking what steps they need to take

to launch a smart community philosophy and how to best organize to achieve the results desired by the community at large.

Chapter 4. Process. Any technology initiative requires a critical understanding of how technology works before beginning. Equally important is a grasp of how the organization and the stakeholders in that organization work. Without support from the organization, it’s difficult to achieve the full results desired.

Chapter 5. Case Studies. Smart community projects take many different forms. The case studies in this chapter highlight the many ways that a local government can put into place a smart community initiative.

Chapter 6. Smart Questions. It’s been said that the best questions are ones that lead you to ask even more and better questions. These questions can be used to begin a dialogue on how your local government can become an effective smart community.

The two appendices move the discussion further by providing a quick take on technologies to keep your eye on and additional resources.

Throughout the book hyperlinks are in bold blue type.

¹ *Technology In Western Civilization: Volume 1. The Emergence of Modern Industrial Society—Earliest Times to 1900*, M. Kranzberg and C. W. Pursell, Jr. (Eds.), Oxford University Press, 1967.

Chapter 1

Overview

Futurist Arthur C. Clarke is attributed to have once said, “Before you become too entranced with gorgeous gadgets and mesmerizing video displays, let me remind you that information is not knowledge, knowledge is not wisdom, and wisdom is not foresight. Each grows out of the other, and we need them all.”

Clarke’s words continue to ring true as city and county leaders seek to enhance effective management and superior service delivery through the astute use of available technologies. This e-book speaks to the technology challenge all communities face. It aims to raise the consciousness of local government managers regarding what constitutes a smart community as well as to offer examples through case studies of how smart cities of all sizes are deploying new technologies to benefit citizens.

But first, some context.

Challenges of Urbanization

Throughout human history the human imagination and development of tools or technological innovation have been the great enablers of the success of human civilizations and the development of cities. In 2008, a United Nations report noted a decisive turning point in history occurred when the world population reached over 7 billion people with more than half (54 percent) of those people living in urbanized areas by 2012. By some calculations this represents the addition of 250 million people a day, or a population increase the size of London each month.¹

These urbanized areas use nearly 75 percent of the world’s energy and produce over 80 percent of the greenhouse gas emissions.² Urban buildings alone account for 40 percent of that energy usage.³ The serious challenges of this era in human history—including rapid urbanization, exponential population growth, climate change, natural resource scarcity, and expanding connectivity of the global village—have served as drivers of a “smart cities” movement around the world. These so-named smart communities are once again using human imagination and smart technology to design and operate more sustainable communities.

Improving Managerial Decision Making

City managers and elected officials recognize that smart technology and new analytical platforms can create the means of improving lives in urban places. Already automation and computerization have improved the efficiency and effectiveness of government services. The Internet of Things (IoT) impacts nearly every activity of daily life as the explosive growth of smart devices in homes and vehicles connects people and machines in data-producing networks.

Only in recent years has technology shown the prospect for improving managerial decision making through automated data collection, and the use of analytics is allowing administrators to gain greater knowledge and understanding of the places they inhabit. Rapidly developing artificial intelligence, cybernetics, and predictive modeling will further help us better design the communities we can imagine and more wisely manage them.

“Our intent is to shorten the distance between the technology haves and have nots and help readers learn from and build on the foundation of early adopters.”

While the future for smart communities is here today, the opportunity to implement smart technology is not evenly available among our global communities, nor is the magnitude and speed of change equally recognized by all public leaders. With this publication we are sharing the experience and understanding of some communities, large and small, that are forging a future enhanced by technology. Our intent is to

shorten the distance between the technology haves and have nots and help readers learn from and build on the foundation of early adopters.

Smart Cities Definitions

You can find many definitions of “smart cities,” or what is also referred to as “intelligent communities.” We are using the definition from the Smart Cities Council (SCC; www.smartcitiescouncil.com):

“A smart city uses information and communications technology (ICT) to enhance its livability, workability, and sustainability.”

Many readers may prefer a more holistic descriptor, also found on SCC’s website:

“A **city** can be defined as ‘**smart**’ when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory action and engagement.”

“Smart cities projects **make cities work better**. They apply information and communications technology to accurately monitor, measure and control city processes, from transportation to water supplies, the location of city vehicles to the performance of electric grids.” Smart cities are about saving money, becoming more efficient and delivering better service to the taxpayer.”⁴

According to the Intelligent Communities Forum (<http://www.intelligentcommunity.org>),

“Intelligent communities” . . . seek to **make better cities**: places large and small, urban and rural, where citizens and employers thrive and prosper in the broadband economy. Intelligent communities adopt technology but do not make it their focus. Instead, they find vision-driven, community-based, technology smart solutions to their most urgent problems. These issues may differ place to place and include social equity, resource conservation, transportation, economic development, and urban architecture.”⁵

Lou Zachrilla, co-founder of the Forum, quipped at an Alliance for Innovation “Big Ideas” conference that “while people create technology, God created [human] intelligence” to use it wisely—a reminder that technology deployment is not the ultimate purpose; rather, inhabitable, smart sustainable communities are the goal.

Both the Smart Cities Council and the Intelligent Communities Forum use the term “cities” generically because both organizations recognize that many technology solutions are best deployed and used within a countywide, metropolitan, or regional context. Cliff Thomas, managing director of smart and connected communities at Cisco Systems, indicates that while density assists smart cities, the sweet spot for smart solutions is not the largest cities but cities with populations between 100,000 and 1 million. Thomas (presenting at the Stanford Business School’s Innovations of Smart Green Cities, What’s Working, What’s Not Conference) contends that worldwide these places contain over one-third of the world’s population. Geographic areas of any size can form what is called “technology ecosystems,” where even smaller communities in urban areas below 100,000 populations can receive benefit from smart technologies deployed by others.⁶

For the purposes of this book we use the terms “smart” and “intelligent” interchangeably and simply reference “smart communities” and “smart cities” as representing all types of government jurisdictions that share sense of community and concern for their future.

“ We use the terms . . . “smart communities” and “smart cities” as representing all types of government jurisdictions that share sense of community and concern for their future.

Technology Innovations Enabling Smart Cities

Research institutions around the world are developing amazing technological applications for cities. Here’s a sampling:

- MIT’s Sensible Cities Lab, in a project called Trash Track, has worked with hundreds of citizens in Seattle, Washington, to install geocoded sensors on waste products to trace their disposal across the country.⁷
- IBM worked with the city of Rio De Janeiro, Brazil, in preparation for the 2016 Olympics to create a Rio Operations Center monitoring every aspect of

the city's 40 departments and urban environment with interconnected cameras, sensors, and weather monitoring using IBM's Deep Thunder localized weather-monitoring platform.⁸

- New York University's Interactive Telecommunications Program developed "Botanicals," a microchip and moisture sensor that allows houseplants to tweet their need for water to willing caretakers in corporate offices.⁹

In a recent *Business Insider* article, venture capitalist Chris Dixon identified a list of 11 technologies—from self-driving vehicles to virtual reality, better food through science, and cryptocurrencies—that the private sector is already deploying that we can speculate will inspire local governments to deploy to become smart communities. For a complete list of these and other technologies and their applications, see Appendix A, Technologies to Watch.

Keeping the End in Mind: Smart Visions and Leadership

Successful implementation of smart solutions requires forethought and planning. As a critical community infrastructure, smart technology needs to be deployed as a part of a thoughtful, smart community vision. This requires an awareness of community needs and knowledge of threats and opportunities as well as the existing civic capacity to achieve a well-articulated smart vision.

“ Smart technology needs to be deployed as a part of a thoughtful, smart community vision.

Quantifiable baseline knowledge of operational metrics and community indicators of the desired outcome are vital to smart solutions and systems development. Smart communities know what they are trying to create and the partnerships they need; they then develop strategies to incrementally achieve their goals.

Smart communities rely on **leadership that inspires and creates a flexible but comprehensive smart city vision and strategic plan** that incorporate technology for the community. Values of transparency, civic engagement, and collaboration and a focus on performance permeate community leadership and visioning processes.

Finally, three core beliefs seemingly underlie the adoption of a smart community vision:

1. Appropriate technology is the critical enabler that can be used strategically to solve community problems and improve services or governance.
2. Appropriate technology itself is value neutral, and when put in place, respects community values; it must be considered an essential public infrastructure.
3. Appropriate technology, open data, and analytics enable public leaders to create communities that enhance and empower the lives and health of citizens.

Examples of these visionary leadership and planning efforts are plentiful:

- Portland, Oregon, worked with IBM Smarter Cities Initiative to develop a 25-year smart city strategy.
- Chicago, Illinois, has developed the City of Chicago Technology Plan to describe its vision and plan for the interconnected and open data environment Chicago intends to develop in partnership with the private sector and citizens.
- Arlington, Virginia, began a broadband network by first connecting its community facilities, then expanding to support facilities and schools. Arlington then connected to businesses and industries to strategically provide community infrastructure to facilitate more economic development.
- Longmont, Colorado, located away from interstate highways and without an institution of higher learning, similarly acquired and used its hydroelectric plant and distribution system to reposition itself into a power and communications utility to deploy broadband throughout its community.

An Innovative Environment Supports Smart Cities

As the case studies in this publication reveal, smart communities purposely create or respond due to necessity or opportunity with an environment supportive of smart technology. Often this innovative smart environment becomes a brand or source of pride. Creating such a supportive environmental community system begins by:

- **Developing insights into a technology-enhanced community future.** This begins with the public leadership perceiving or discovering that a particular technology has

an application or can be adapted in an act of innovation and deployed to improve performance in a service delivery, infrastructure, or governance process.

- **Assessing community capacity and timeframes for deployment.** This involves assessing the fiscal resources needed for acquisition or necessary for a return on investment, verifying the technology's performance capability, and identifying sources of data. It also involves determining timeframes to efficiently deploy the specific technology.
- **Identifying partners and facilitating the collaboration necessary to implement the vision.** Collaboration is necessary to integrate the technology into existing operations and community systems. This may be through a public-private partnership or an intermediary agency, or through creation of an innovation hub or innovation district to shelter the process and encourage funding.

A Roadmap for Technology Deployment

Once a community has agreed upon its vision, strategy, and goals, a technical roadmap for the journey to becoming a smarter community is accomplished in three critical, cohesive steps.¹⁰

Data collection. The first step, as essayist and poet Ralph Waldo Emerson wrote, is to “know thy self.” This occurs when a city collects informational data about itself. The city collects data by creating electronic networks of sensors, monitors, and other machine-to-machine (M2M) or smart devices, such as utility meters, building monitors, and fueling systems.

Networked communication. Second, the city develops capabilities—from smartphones to broadband networks—that can communicate information in the form of wireless or wired networks of data about the community to its internal agencies and other collaborative partners. The Internet of Things (IoT) adds to the growing capabilities for such communication, such as smart utility, street, and building grids.

Descriptive and predictive analytics. And third, the community “crunches” the expanding data by using descriptive analytics to understand the data and what it means about the community. Leaders can then use predictive analytics to model what the future will be or what different resource allocation scenarios can alter future prospects.

Recognizing the neurological preferences in the human brain, visual analytics are increasingly used to assist

identifying relationships within data or to display it visually for enhanced understanding and communication to employees, elected officials, and the public.

Benefits of Being a Smart Community

The Smart Cities Council publishes a *Smart Cities Readiness Guide* for local officials that cites 17 benefits of smart cities under three categories: livability, workability, and sustainability.

- Smart communities are more **livable** because of the ease of access to civic participation, community functions, and government services; more transparent by sharing open data; and safer and more responsive with alerts and monitoring of situational changes in the community.
- Smart communities are more **workable** because technology fosters economic development by unleashing innovation, developing world-class infrastructure and protection through enhanced cybersecurity.
- Smart communities are more **sustainable** because they can monitor and optimize limited resources, improve interoperability, and reduce costs of infrastructure by sharing and reusing resources, conducting better computer simulations, and initiating fiscal forecasting.¹¹

The benefits are often practical. Think about the typical changes in solid waste operations that we've seen in the work lifespan of many managers today and the impact of those changes on citizens. Many managers remember (circa 1950s–1980s) when there were four or five employees on a garbage truck, and crews may have gone into the private backyards or alleys of residences to retrieve trash cans of any size and dump them in rear-end-loading garbage trucks. Then technology allowed for automated side loaders (circa 1980s and 1990s), and crews were reduced to one or two employees. Local governments made citizens move specifically designed containers required by this technology to their increasingly suburban front yards to be placed a specific distance from the curb. In that action public administrators ushered in the concept of co-production with citizens.

Communities started mandatory recycling nationwide in the 1980s, with citizens often sorting their own recyclables and taking them in separate containers along with their trash to the curb, creating alternative waste streams, new products, and reduced landfill overcrowding.

Smart technology exists now that can allow communities to likely have solid waste fixed routes served by automated driverless garbage trucks and containers in automatic carts to move household refuse curbside on appropriate days. We already know that cities in the world are currently being designed and constructed so that there are few or no trash trucks and pneumatic tubes take wastes from homes directly to centralized waste facilities as the trash is produced. Perhaps the future holds little human involvement at all as cyborg robotics crews accompany the truck to help with loading recycling trucks. Or perhaps camera-equipped drones will fly routes in front of trucks to determine and predictively change daily work schedules and routes based on what types or amounts of waste is generated citywide through analytical routing programs. This is one of many examples of practical, smart technology applications we can foresee and that are enabling the delivery of improved services to residents.

Human Values in Smart Communities

Many technologies can be disruptive to communities and have unintended consequences on human values despite our collective intelligence. What is technologically feasible may not always be best for the community, nor can legal frameworks protecting individual rights keep pace. Historically, rural Amish communities and some secular intentional communities around the country have sought community deliberation on which modern technologies will be embraced or are supportive of community values.

In today's urban society, with the rapid pace of change and the introduction of innovative technology, such community deliberation on the impacts of technology appears impossible or secondary in the face of market forces and consumer preferences. Machine-to-machine intelligent technologies are creating smart ecosystems affecting human behaviors. Most of us recognize how often our devices demand our attention, and surveys (including ICMA's 2016 Smart Cities Survey) show that budgetary limitations and discussions of economic feasibility tend to chiefly govern decisions to use smart cities technology.

Deploying smart technology may have negative impacts on the community that public managers need to anticipate and mitigate. Airspace filled with delivery drones may be a future zoning issue or violation of privacy. Militarized policing technology may alienate parts of a community. Autonomous vehicles and robotics can reduce public employment, remote

learning may threaten local learning institutions, sensor- and camera-based analytics can easily violate civic rights and privacy concerns.

Artificial intelligence critics fear the loss of human judgment at the moment of a critical ethical decision. Nevertheless, smart technology solutions, such as alternative shelters, can enhance compassionate social problem solving around such difficult issues as homelessness, and where successfully deployed, new infrastructure can create employment and economic growth.

Barriers to Smart Communities

Obstacles to smart city efforts were recently recognized in the **ICMA and Smart Cities Council's 2016 Smart Cities Survey Summary Report**, a survey of ICMA members. Chief among these barriers is the concern about how to finance the significant costs of technology acquisition and maintenance. Other issues cited as impediments to smart cities were difficulties overcoming institutional silos, integrating solutions with legacy systems, overcoming archaic procurement practices, and lack of a trained ICT (information and communications technology) workforce. A mitigating strategy to bridge these barriers is leadership that builds a common vision among competing agencies and neighborhoods to encourage collaboration for widespread deployment of analytical and infrastructure solutions.¹²

A Future of Empowered, Connected Smart Citizens

Inventor, author, and architect Buckminster Fuller said, "We are called to be architects of the future, not its victims."

The environmental, social demographic, and economic drivers of smart communities will become more paramount in future decades as urban spaces keep growing. The World Health Organization predicts that by 2050 the world's population will reach 10 billion, with nearly 70 percent of the population living in the world's urban areas.¹³ The global capacity to create and conserve resources to meet these challenges once again will depend on our human imagination and our willingness to develop and rebuild communities deploying smart systems in communities worldwide.

If we desire to have future-ready, resilient, and sustainable communities, public administrators can expect to have the opportunity to engage connected smart citizens in the governance process in ways never before available. There

are already more smartphones than people worldwide. In 2015 more than 25 billion smart devices were in use, and this number will double by 2020 with more explosive growth in undeveloped countries.¹⁴

Justin Cook, of IBM's Smarter Cities Initiative, indicates that we can expect the world to be increasingly "instrumented, interconnected, and intelligent" in the future, making systems thinking essential.¹⁵ Urban systems thinking revolves around more than utilities, buildings, and roads. Citizens, their behaviors, and their level of civic engagement are central to demands on urban and global systems. Smart cities will have smart citizens.

“ Smart cities will have smart citizens.

Imagine citizens using technologically powerful smartphones as minicomputers, enhanced with built-in artificial intelligence and remote learning, in local and global networks of citizens. These connected smart citizens will be better equipped to be citizen scientists, citizen journalists, citizen peace-keepers, and citizen environmentalists. This future level of global civic engagement and community capacity building will blend human imagination and technology in a way that has not been experienced in the history of the world.

Endnotes

- 1 *The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life*, C. Rotti and M. Claudel, Yale University Press, New Haven, 2016.
- 2 Energy for Cities, ARUP, www.ARUP.com.
- 3 Presentation of Cliff Thomas, "Rise of the Smart City" at Innovations of Smart Green Cities What's Working, What's Not" Conference, June 2012, Stanford Business School.
- 4 Smart Cities Council Smart Cities Readiness Guide, <http://readinessguide.smartcitiescouncil.com>.
- 5 Intelligent Communities website www.intelligentcommunities.org.
- 6 Presentation of Cliff Thomas, "Rise of the Smart City" at Innovations of Smart Green Cities What's Working, What's Not" Conference, June 2012, Stanford Business School.
- 7 *The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life*, C. Rotti and M. Claudel, Yale University Press, New Haven, 2016.
- 8 *Smart Cities, Big Data, Civic Hackers, and the Quest for a New Utopia*, Anthony Townsend, W.W. Norton & Co, New York, 2013.
- 9 Ibid.
- 10 Smart Cities Council Smart Cities Readiness Guide, <http://readinessguide.smartcitiescouncil.com>.
- 11 Ibid.
- 12 Smart Cities Survey Summary Report, ICMA, 2016, icma.org/2016smartcitysurveyreport.
- 13 Presentation of Cliff Thomas, "Rise of the Smart City" at Innovations of Smart Green Cities What's Working, What's Not" Conference, June 2012, Stanford Business School.
- 14 Ibid.
- 15 Presentation of Justin Cook, "Systems Thinking for Smarter Communities," Price School of Business, University of Southern California, November 2011.

Chapter 2

Understanding the Role of Local Government Leaders

Innovation in smart communities is being driven by both technology developers and visionary local leaders. Managers sometimes overlook their important role as early implementers and beta testers. Likewise, it is easy for the second-tier implementers who copy or adapt from the innovators to dismiss their role in helping smart technologies reach the tipping point of economic viability to become standard industry practice.

At one point, wireless meter-reading technology was in its infancy, as were the signal preemption devices used by fire departments to speed their way to the scene of an emergency. Did this mean that early investment in those fields was a mistake? Certainly not.

Likewise, when “car phones” first became available, many communities took advantage of that technology to increase the connectedness of key staff. Was this a waste of resources? Again, the answer is no, unless the list of staff to whom car phones were assigned or the pricing structure didn’t make sense.

No technology is right or wrong for smart community implementation in and of itself, and no community is right or wrong either. Careful assessment of the goals to be achieved and of the community’s financial and organizational commitment is what makes successful implementation of smart technologies possible.

So what are the roles of local leaders?

- **Vision:** Understanding the challenges and opportunities posed by technology
- **Planning:** Incorporating smart community considerations into strategic discussions and goal setting with department heads and elected officials
- **Leadership:** Exhibiting a willingness to stand at the vanguard of implementation for new approaches to service delivery or organizational management
- **Collaboration:** Identifying and fostering relationships with other key stakeholders
- **Commitment:** Sticking with the larger concept, even as individual ideas may not prove successful

- **Ethics:** Maintaining an equitable and open process for rolling out services to various neighborhoods and demographic groups.

Vision

Vision is an intangible that may originate from multiple points within the community—from elected officials; from managers, department heads, and other staff; or from private sector leaders in the community. All have the capacity to spark action within the smart technology sphere. Indeed, within a high-performance organization, that vision may be most likely to be expressed by any number of empowered employees throughout the organization.

The transformative nature of smart community technology lends itself to higher level policy decisions, as it is important that those new visions align with the larger priorities expressed as part of the budget or strategic plan.

The essential role of the manager or other organizational champion of the smart community approach, then, is to act upon that agreed-upon vision to:

- research the regulatory and business environment
- set an implementation plan
- incorporate the agreed-upon vision into the culture of the organization.

In this way, the smart approach becomes not just a standalone project in a single department, but part of a shared, cross-departmental commitment to continuous improvement and innovation.

Use of SWOT analysis. Insanity is said to be doing the same thing over and over and expecting different results. In the business world, we often see this in practice when an entrepreneur ignores the three rules of real estate (location, location, location) and opens a new restaurant in a spot where several others have failed. For local governments, the location is already set, as are many of the legal, operating, and financial constraints. Can a government persevere using the same budgeting and service delivery processes year after year? Probably, but the results might be well below the jurisdiction’s potential.

For a new restaurant to succeed or for a local government to break past simply a passable level of performance, it may take a new approach. In terms of smart technology, the starting point may be a SWOT analysis (see table below).

As you think about those strengths and opportunities, remember that not all potential partners, resources, or competitors need to be organized, bricks-and-mortar institutions or wired jurisdiction-built networks. Whether gathered together via social media, hackathons, crowdfunding campaigns, or crowdsourced data input (via CRM [customer relationship management] software or **smart phone sensors**), your connection to residents generally or to particular target groups (e.g., retirees, students, techies, nonprofit organizations) can generate more than the sum of its parts.

Where is your community right now? Work with your department managers and planning, public works, and

economic development staff to complete a similar analysis to determine where your opportunities lie. Don’t assume that the information technology staff need to lead the way. Remember, too, that quick wins (those low-hanging fruit opportunities) build a foundation of trust and validate the decisions of leadership and staff—which in turn begins to open the door to implementing future new technologies.

Planning

If you have systems or facilities scheduled for replacement or maintenance, how could you incorporate smart technology into the planning effort to ensure you have the capacity to pursue such initiatives in the future, even if they’re not part of your day 1 plans? Is your right-of-way sufficient not only for sidewalks and signal controllers but for potential broadband deployment or improvements? Is your capital improvement program just another document on your shelf or something you actively discuss with potential business and technology partners?

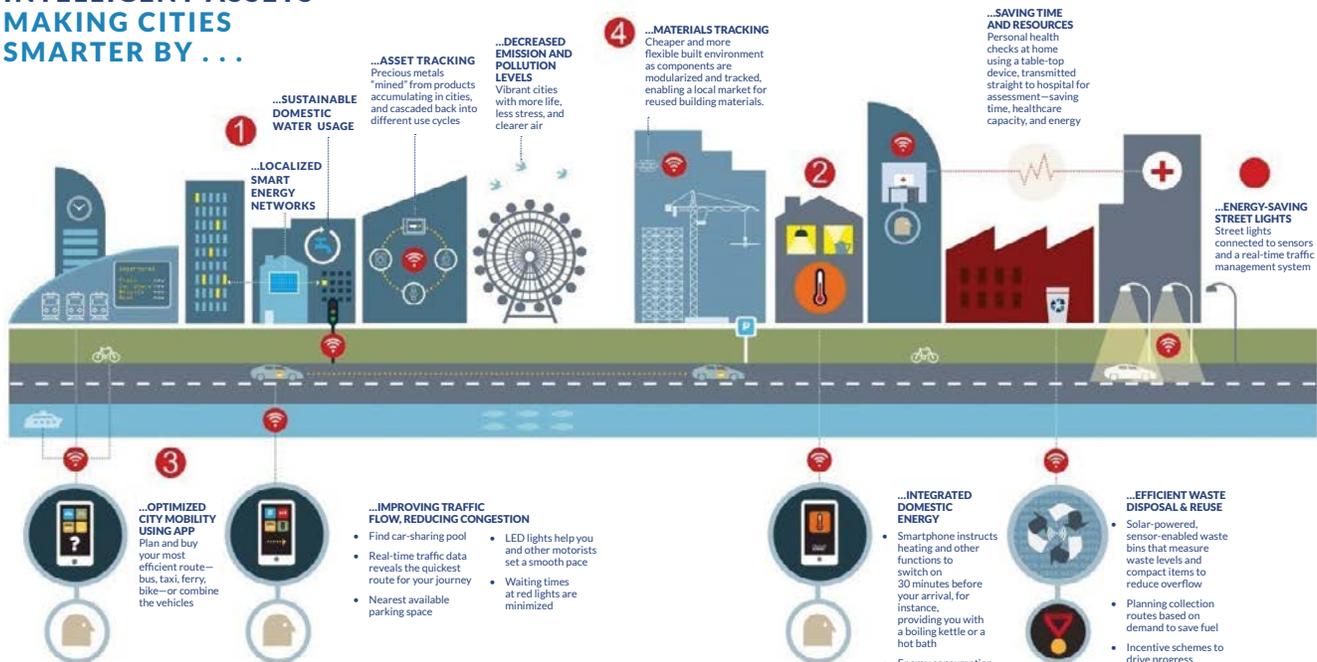
Regarding management software, building HVAC, sprinkler controllers, traffic signal timing, or other systems, you might ask yourself:

- What features would we spec if we were fully replacing the system today?
- Even if the system is not wired now, how might the Internet of Things enable better data collection or automated control?

Smart Community SWOT Analysis

SWOT	General considerations	How does my community stack up?
Strengths	Community resources and key stakeholders (e.g., universities, hospitals, major employers); existing systems and networks; available land for new or brownfield development	[Your analysis goes in this column.]
Weaknesses	Limitations of legacy infrastructure; financial constraints; organizational inertia; lack of technological expertise among staff	
Opportunities	Public-private partnerships; pending capital projects; potential to energize staff and foster community engagement and innovation	
Threats	Quick technological obsolescence; potential for failure; perceived overreach or straying from core community priorities	

INTELLIGENT ASSETS MAKING CITIES SMARTER BY . . .



Source: World Economic Forum and Ellen MacArthur Foundation, *Intelligent Assets—Unlocking the Circular Economy Potential* (2016), www.ellenmacarthurfoundation.org/publications/intelligent-assets. Used by permission.

- What interconnects or software integration would facilitate better management through cooperation with other jurisdictions, local utilities, or other agencies?
- What do we anticipate the service delivery model will look like in 30 years?

When was the last time we dedicated time to these larger questions? Former Defense Secretary Donald Rumsfeld famously talked about “known unknowns” and “unknown unknowns.” Looking back 30 years from today, most people were probably not thinking of a coming revolution in drones or driverless vehicles, but for those who started to put the pieces together back then and talked as an organization about how to keep their plans up-to-date, there were fewer unknown unknowns and a much faster adaptation to the next important opportunity.

Leadership

Being a leader on the technology front can feel a little like gambling, and that’s not something that most professional public managers are inclined to do with the public’s money. But just because you’re a good steward doesn’t mean you can’t be a role model for smart communities.

If there’s a focus group, beta site, demonstration vehicle, grant-funded project, cooperative RFP, or other no-consequences approach, this is a much more comfortable

step into the arena. Likewise, a proliferation of outside-funded consortia are helping ease the path to leadership by providing resources and support along the way. (See **Chapter 3: Getting Started.**)

One of the fallacies about leadership in smart communities is that you need to be in a large metropolitan area. Population size and density can certainly be an advantage, due to the number of complex systems present in a large metropolis—such as light rail systems. However, when it comes to rolling out new technologies, smaller scale implementations can be just as effective.

Collaboration

If you’re blessed to have all the right people in your organization already, then becoming a smart community will be easy. For everyone else, you’ll want to consider how best to leverage other types of expertise, opinion, and resources. At the very least, such outside voices may bring with them other considerations you hadn’t yet articulated, other funding sources, or other stakeholders to assist in the implementation.

In all likelihood, the state and federal governments will not be knocking down your door to provide you with grants, but there may still be some grant funds or foundation assistance available. If not, start with the industry partners who are active in the field and solicit feedback or cooperation from colleagues in other jurisdictions.

Commitment

As a cutting-edge field, investing in smart community technology does bear a certain risk that one or more initiatives may not be successful. This is where a manager's long-term perspective is key. For every Solyndra that fails, there may be just as many like Uber, Amazon, **SeeClickFix**, **Siemens**, and **Johnson Controls** that are going strong. The challenge is not how to never pick the wrong one. Occasionally, you will. Instead, focus on how to protect the community's interests via careful contract and partnership review and diligent risk analysis.

And when you're met with setbacks, even as you work to minimize the impacts of that bad outcome, remain committed to the larger focus on smart communities, as that will continue to serve your jurisdiction well in the years ahead. Missteps, setbacks, failures—they are, after all, opportunities to ask, what did we learn?

From a process standpoint, the best approach to expressing organizational commitment may be to:

1. Bring together the technical, financial, and operational information from a variety of departments to form a business plan or prospectus, and
2. Hold a smart community summit where the plan can be discussed among management, department heads, elected officials, other community stakeholders, or even representatives from other smart communities who have a relevant track record.

“ Missteps, setbacks, failures—they are, after all, opportunities to ask, what did we learn? ”

The result may be incorporation of a “smart” goal into the strategic plan or possibly just a resolution of intent. Even when a resolution may offer only nonbinding support for the concept, it is a powerful message to those inside and outside the organization that the smart technology approach is not the brainchild of a single individual or department stepping too far ahead of the broad policy direction. If you happen to be the department head who's spearheading the initiative, this is also a great way to energize other stakeholders who might not yet be on board.

SMALL COMMUNITIES LEADING THE WAY

As such as we think of Google Fiber hubs as the proving grounds for key broadband infrastructure, the small communities of Cedar Falls and Hawarden, Iowa, were busy establishing their own telecommunications and broadband networks in the early 1990s (when their respective populations were 35,000 and 2,500).¹

Small size may also not be a disadvantage where emerging technologies need to rely on partners outside the core metropolitan communities. In rural Morrow County, Ohio (population 35,000), economic development officials worked with Tesla to open a new 10-vehicle high-speed charging station in the community. The station serves as a resource for local area businesses and residents, an attraction for new business location decisions, and a waypoint for vehicles transiting through the area from Columbus to Cleveland.

¹ A Tale of Two Iowa Cities: Cedar Falls and Hawarden, Taking the Lead in the Information Revolution,” ICMA Best Practices Symposium Case Study, 1999.

Ethics

As was pointed out in Chapter 1, rolling out a new technology can lead to concerns about invasion of the privacy of your local residents or businesses. But even if there's no private or individually identifiable information stored, you may face ethical considerations:

- Who benefits from the technology?
 - » If the implementation is phased in to serve certain neighborhoods first, are those neighborhoods selected in an equitable and open manner? If your elected officials represent districts, do the pilot areas touch all districts, or are they based on other objective criteria, such as demonstrated service delivery challenges in some neighborhoods more than others? Consider how a less-than-equitable map might be perceived if it became a headline story in the local media.

- » If the technology will be implemented in partnership with a private company, is the vendor selection process transparent enough that residents can be assured no **favoritism** has been granted?
- What unintended consequences might it promote?
 - » If there are revenues to be generated, is there an incentive on the part of the vendor or those administering the technology to over-enforce? Such concerns have been an issue in **Chicago's contract for parking meter administration**, and a number of

jurisdictions have walked the fine line between public safety and budget boosting with red-light or speed cameras.

Whenever such questions are not fully explored and dealt with up front, and clearly communicated with local residents, they run the risk of eroding public trust. No matter what your formal role is within the organization, you can serve as an effective leader of the smart community implementation by working to ensure that each of these questions is fully explored.

Chapter 3

Getting Started

Long before you enter the exciting stage of actually implementing smart technologies, you'll need to conduct extensive research and analysis. As Coral Gables, Florida, staff discuss later in this book, thorough preparation as well as investigation into others' experiences (and missteps) are what can help you be successful. Be sure to factor in this exploratory "doing your homework" time as you venture into adopting potentially transformative smart technologies.

Among the considerations prior to adopting smart technologies are these:

1. What issue or problem are you trying to address with new technology?
2. What are your current capabilities and gaps?
3. What functionality is must-have core capability and what is optional?
4. Who's already doing what it is you want to implement?
5. What is the regulatory and technology environment?
6. Does what you're proposing fit the organizational or community culture?
7. How are you going to measure success?

And perhaps most importantly:

8. Who needs to be involved?
9. Who's paying for all this?

1. What Issue or Problem Are You Trying to Address with New Technology?

Are your goals clear? Will this technology simply be replacing the existing system, or is it intended to solve a problem facing the community? If it's the latter, can you tie the need for the new technology into the goals and priorities of the strategic plan? Making such linkages can help you communicate the importance of the technology implementation to policy makers and the public as they prioritize your budgetary requests.

“... Can you tie the need for the new technology to the goals and priorities of the strategic plan?”

Have you asked your constituents what their pain points are—what government services they believe should be more effective or efficient? Have you asked staff members the same question?

Beyond the immediate goals, what are the long-term aspirations you're trying to achieve? Strategic plans may run for 5-10 years, but communities may also be charting their likely development plans for the next 50 years. Does this technology have the scalability to meet the needs of the community as it continues toward build-out or in-fill development of key corridors? Or if your community has staked out a **BHAG (big hairy audacious goal)**, will this technology help make that a possibility?

2. What Are Your Current Capabilities and Gaps?

Technology projects can start from a perceived need, either based on the obsolescence of the currently-in-use system or an attempt to remedy an existing lack of automation. They may also arise from recognized convergences of previously separate technologies or the appearance of a new technology in the market.

For example, the initial capability might be a server-based financial system being replaced by a cloud-based application with integrated mobile apps. Or, an entirely mechanical process (park irrigation) could be brought online as one more set of endpoints on the Internet of Things. In the case of driverless cars, existing GPS technology is merging with on-board park-assist, break-assist, and other sensors.

Step one in evaluating your current capabilities is determining whether they're truly in need of replacement. Even when a new system is viewed as the emerging industry standard, that's not to say there's an imperative to replace

the old. Granted, the U.S. could have fully converted to the metric system years ago, but highway managers and vehicle manufacturers have been perfectly comfortable with mile markers and mile-based odometers, so except for its presence in 5- or 10-K runs, the kilometer remains a clunky, nonessential upgrade.

From a technology perspective, the question to ask is whether the old system needs to be replaced outright or whether upgrades, patches, or complimentary technologies can improve functionality incrementally. If so, the benefits in foregoing a new learning curve may justify a decision simply to build off the status quo.

To properly assess what your capability gaps are, start by talking to your customers. If local residents and businesses are talking about the need for flexibility in accessing city/county permit services during off-hours or via mobile app—perhaps because they’ve experienced that convenience in other areas—that’s a good indication that a gap exists. Likewise, if staff are indicating frustration at a lack of easy workflow around shared processes, or if businesses are looking past your jurisdiction based on sub-par broadband or transportation networks, you may have some gaps that you need to address.

3. What Functionality Is Must-Have Core, and What Is Optional?

So once you’ve decided to proceed with a new technology implementation, you’ll need to craft a request for proposals that defines the needed and optional capabilities. This should also be reflected in your evaluation plan so that the most responsive vendor is not the one that offers the most moving parts but the one that best meets each of the essential requirements.

Remember that the end goal is not the latest technology itself but its usefulness to the community and/or to your staff. Where you anticipate some optional services or subsequent releases being of potential interest later, you may also want to spec add-on rates for those services if and when you’d want them.

“Remember that the end goal is not the latest technology itself but its usefulness to the community and/or to your staff.

Smart communities can incorporate incredibly efficient, interconnected systems, but as Jared Diamond discusses in [Collapse: How Societies Choose to Fail or Succeed](#), that complexity or our own hubris can also be a potential liability. You might wish to consider what potential downfalls are inherent in a more complex or fully-integrated solution.

- If you add the full gamut of potential features, will your processing speed be compromised?
- Will memory or data storage limitations mean you’ll be incurring added expenses?
- Does a single failure, outage, or hack lead to potential loss of control on an entire utility grid, communications network, or other essential system? Or are vulnerabilities segmented to keep such potential impacts more localized?
- If the system does go offline, even temporarily, what are your contingency plans for manual or semi-automated control or for quality assurance? For example, how would you maintain backup quality assurance at water treatment facilities?

Another question you shouldn’t ignore is whether a smart solution is necessarily better than any other technological solution. Will the benefits of Internet connectivity improve your operations more than other available technology? How much additional benefit will you gain from intelligent irrigation controllers if the rainfall in your area is fairly predictable and your systems already enable timer or override programming? What is the marginal benefit of remote smart metering versus meter readings done via existing handheld readers? What are the additional vulnerabilities?

The connectedness of the Internet of Things has [implications for consumers](#), but the added responsibilities for those who are the stewards of local utilities and other public services demand that you perform a careful cost-benefit analysis in selecting the right features and mitigating the potential risks.

The advantages of fully-integrated solutions are typically quite abundant and obvious—for example, maximizing two-way communication about utility demand, system capacity, time-of-use metering and incentives, and efficient building management for the jurisdiction, residents, and businesses. The point here is to push your thinking about not only the expected improvements but also the associated and perhaps unintended ramifications.

4. Who's Already Doing What It Is You Want to Implement?

There are definite advantages to being beta testers of new technology, particularly if that means discounted or advance access to the latest capabilities. But if being the beta tester means you're locked into using Betamax rather than VHS, or DVDs rather than streaming video, then perhaps being first has its disadvantages too.

Odds are that for most smart technologies you might want to deploy, someone has already deployed it elsewhere. Whether in local government, private industry, the military, or even just at a proving ground operated by the developers, systems are already in place and available for review. Rather than relying on verbal recommendations, consider where it's possible to see those applications in person to explore more fully

- How their implementation went
- What financial or other assumptions proved incorrect
- What mistakes they made, or what they'd do differently now
- How your differing circumstances might make the same approach infeasible (e.g., older infrastructure, narrower streets, colder climate, lower population density, geographic barriers, etc.).

Given the wireless nature of most smart technology, you may even be able to arrange for a jurisdiction that's already using a particular smart technology to provide a live demo of the system capabilities via laptop or mobile device from the comfort of your own conference room or council chambers. As the Jacksonville, North Carolina, case study describes, Jacksonville implemented an automated traffic management system linking 73 major intersections to a traffic operations center. And while the command center officially resides at city hall, staff can also access the system via laptop for on-the-fly adjustments even after hours.

5. What Is the Regulatory and Technology Environment?

It sounds great on paper, but...

Unfortunately, many of the creative approaches considered by local government run into roadblocks set up by their state legislatures, the federal government, utility commissions, or industry lobbying groups. Before you bother

investing resources in the concept development, talk to your attorneys, risk managers, IT managers, and intergovernmental relations staff to identify the hurdles you may need to clear before the idea can become a reality. If there are legal or bureaucratic limits, consider whether special legislation authorizing your jurisdiction as a test site might facilitate a work-around.

You might also conduct an environmental scan of the other actors, stakeholders, competitors, or potential partners in such an implementation. This might include other communities, even if they're located in other states, or regional, nationwide, or international networks and standards, such as [Smart Cities Council](#), [Global Cities Team Challenge](#), [Institute for Building Technology and Safety](#), [STAR communities](#), [ICLEI](#), [LEED](#), and [What Works Cities](#).

As far as getting a handle on the technology environment itself, determine whether there's a relevant trade show or exposition that would enable you to visit with multiple vendor representatives at the same time. Then you'll be able to more readily compare and contrast their solutions or determine whether the timing is even right for you to get involved.

6. Does What You're Proposing Fit the Organizational or Community Culture?

A corollary to that environmental scan is an internal organizational and cultural review.

Human resources impacts. If you have labor agreements that discuss the outsourcing or automation of tasks currently handled by employees, work with your human resources, training, or employee association representatives to ensure that you don't run afoul of those provisions.

For instance, even though it may be a while until you incorporate autonomous vehicles into your fleet, you may want to get a jump on discussing the personnel issues of tasking and staff planning long before you get to the technical issues of maintenance and public safety. Even communities in a non-union environment would benefit from longer term organization-wide discussions around the logistics of such applications rather than simply imposing them in a top-down manner.

A few of the questions to ask about the implications of technology implementation on human resources include:

- What current aspects of tasks are being performed by overqualified staff? For instance, is equipment being delivered to a worksite by an employee whose time is

better spent as the equipment *operator* once the work commences?

- How might a new technology impact the potential need for layoffs, job transfers, or re-training? How clear are your seniority provisions?
- As the labor market adapts to more on-demand, contingent, or **project-based employment**, what implications might this have for existing benefit systems set up for more traditional full-time or part-time employees?

Cultural impacts. Main Street businesses have been affected by big box retailers and discounters. Online shopping is affecting mall stores. Uber disrupted the taxi industry seemingly overnight, with autonomous vehicles now poised to push out Uber drivers as well. Now is the appropriate time to bring your staff together—not as entrenched defenders of the status quo, but as knowledgeable service providers ready to help the organization adapt to the opportunities and efficiencies that emerging technologies can bring.

For many years, **Loma Linda University** was well regarded for its medical school and its focus on nutrition science. When surgeons and hospital directors made the decision to transplant a baboon heart into a human baby, that decision had the potential to drastically change the university's public perception, either for better or worse. The **ethical dilemmas** faced in local government may not seem so revolutionary, but, for example, the application of surveillance technology and artificial intelligence to policing could easily change a community's character from "hometown" to a **Big Brother city** or one with **Terminator technology**.

- Have you considered how those changes enacted with or because of technology would fit with your local culture?
- Have you had a discussion with your elected officials regarding their comfort-level with risk taking and entrepreneurial leadership?
- In your strategic planning discussions (as an organization or within individual departments), is smart technology on the agenda? How are you planning to be an innovator in the field? How are you reacting to changes taking place around you?
- Which aspects of service delivery or innovation are your bedrock commitments and which are changeable? What is your core mission, and how will smart technology advance your mission? What are your community expectations?

Sustainability. One other potential dimension of cultural complexity that can come with the smart community approach is the assumption that adoption of smart technology is dependent upon a "green" conceptualization of sustainability. This issue was vocalized by a staff member in a town split between an environmental-leaning university community and the surrounding, mostly rural and conservative population. Even if the only green you or your elected officials are focused on are the dollars flowing out of your available fund balance, you can still apply smart solutions to the challenges facing your community. In fact, the act of distancing yourself from a more value-laden or politically sensitive approach may help all parties see some common ground.

- Once fully implemented, will the new technology demand more or fewer staff than you're dedicating to related tasks currently?
- Will any new, ongoing revenue streams support operations even after any capital grants are exhausted?
- What are the life cycle costs over the next 10-20 years to operate this new technology, whether for equipment, utilities, staffing, or maintenance?
- What is the system's vulnerability to cyber attacks, run-of-the mill vandalism, or routine wear and tear, and what are your likely costs to defend against such risks or respond to any incidents?

Drone-based cameras might seem like an efficient way to manage your conservation easements or open-space maintenance, but if knocking the drones out of the sky becomes a local pastime, whether due to residents' privacy concerns or criminal mischief, then the replacement costs might mean that approach is not financially sustainable. Likewise, if a technology ends up consuming more electricity, water, or other resources than the value it creates, you might want to consider how to make your implementation more environmentally sustainable as well. A good example of planning for sustainability is in the case study that follows regarding San Diego's solar-to-EV vehicle charging stations.

7. How Are You Going to Measure Success?

It's always best to start with the end in mind. For a smart community application, that end could be the council/board meeting five years from now, when you're asked whether the technology did what was expected. Other than saying that it hasn't crashed, or that it came in within budget, what data are you going to present? Consider these possibilities:

- What is your current level of performance?
- What are your current projections for what your performance would be in five years if you didn't make any changes?
- What built-in analytics tools does the chosen technology bring with it that can help you assess not only the overarching goal but also the performance of individual components?
- How might you start now to facilitate comparisons to other jurisdictions to demonstrate performance against benchmarks?

Performance measurement sometimes goes in fits and starts. It may be, for example, that the first few metrics you choose to measure don't yield accurate results in year one or two. If so, there may be record-keeping or accounting processes in need of tweaking. Regardless, begin planning for a suite of interrelated measures now:

- **Inputs**

- » What staff have you been devoting to the related tasks to this point? Will that increase during implementation? How do you anticipate that changing as the system becomes fully operational? Are staff who are working on this task pre- and post-implementation charging their time to a particular account that can capture the differences in level of effort? If the pre-implementation data are not available, can this at least be estimated (e.g., 0.25 FTEs assigned to utilities management for public facilities prior to wireless/SCADA [supervisory control and data acquisition] upgrades)?
- » What changes do you anticipate in non-staffing costs? Will there be a licensing agreement or marginal additional costs for each node, mile, vehicle, or unit served?

- **Outputs**

- » Will the technology enable you to handle more tasks or workload? If you expect a new transportation management approach to handle more traffic, do you have sufficient pre-implementation traffic counts from locations throughout the jurisdiction to assess your results?
- » Will the nature of the outputs themselves change? For example, if an automated purchasing system enables you to abandon printed purchase orders,

should you perhaps be replacing a count of POs processed with a count of the dollar amount purchased or the number of higher level/longer term contracts negotiated?

- **Efficiencies (and scale)**

- » How do outputs per input compare, such as the staff hours per task, expenditure per permit, or BTUs (British thermal units) per square foot?
- » What are the units being served under the old versus new systems? Are you serving the same population or square miles in year zero versus year five, or do you anticipate annexations to change your baseline? Will in-fill development bring more signalized intersections online within your existing territory? Are you comparing IT costs and FTEs to the number of workstations, but ignoring the range of wireless devices, sensors, and networks served? Make sure to check all components of your calculations and keep accurate records of the formulas so that as staff change, the metrics can be compared consistently.

- **Outcomes: quality, timeliness, equity**

- » Have you been conducting regular citizen surveys so you can compare before/after ratings on affected services?
- » Manufacturers look to the error rate and sample tolerances to determine the effectiveness of new processes. Have you considered tracking similar metrics for negative experiences (e.g., number of complaints, system failures or downtime, occurrences of unsatisfactory level-of-service at networked intersections, employee injuries)? If you're making one part of your processes more efficient, are the more manual portions keeping up, or are you just moving bottlenecks to other areas?
- » What metrics do you have for waiting time? If you're implementing library self-checkout or online permitting, will you be able to tell how the service has improved?
- » Is the technology anticipated to enable more effective queuing of tasks (e.g., so that CRM users see a clear first-in/first-out or other prioritized result to their requests)?

Ideally, you should be tracking a few metrics in each of these categories, as efficiency gains might mean very little if they come at a huge cost in terms of the inputs being

dedicated to the project. Measure as many different aspects of the system as you can, but if you find that some of the results are not quite definitive yet, be sure to:

1. Celebrate the smaller milestones that you do achieve. These interim results will demonstrate movement in the right direction and help keep staff motivated.
2. Report the measures, even if you don't yet have the data. Even if the chart says "Not available" or "In process" in a few places, it keeps you focused on the full range of relevant metrics and may help prioritize some of the other analytics improvements that you'll need to provide data for *each* of those metrics.

Depending on the complexity of the systems you're managing, you may also want to invest in **integrated business analytics systems** that will track your operations and assist in long-term management and process improvement.

8. Who Needs to Be Involved?

Budgets tend to be zero-sum games, with one department's priorities funded at the expense of another department's proposals that are put off until next year. With smart community technologies, an inherent challenge is thus getting all potentially interested parties to be active participants in planning and implementation.

It is not enough for the IT director or some other department head to spearhead the project as her or his own. Considering the potentially transformative nature of the

“... An inherent challenge is ... getting all potentially interested parties to be active participants in planning and implementation.

smart/connected approach and the impacts on community culture, it is imperative to involve a much wider range of stakeholders, including:

- **Line departments.** Often the leaders on the implementation, public works, or public safety departments may bring the ideas to the table.
- **Technical staff.** The IT department, network or radio maintenance staff or contractors, engineers, and planners may hold the expertise to help make the department's vision a reality.
- **Private sector partners.** Industry experts as well as university professors, researchers, or administrators may be able to offer advice about the path forward or provide in-kind contributions of facilities, servers, or broadband networks.
- **Community/citizens groups.** Those most directly making use of the new applications may be the least knowledgeable about its benefits, which is why you also need to involve...
- **Public information, web/social media outreach, and human services.** If you're thinking of the "face" of your organization, it may not be the managers or technical experts listed above but the recreation specialists, librarians, building inspectors, and others who interact most directly with the public. If you're looking to spread the word or conduct a two-way dialogue around proposed changes in the traditional service delivery model, you'll get much more useful information out of these one-on-one interactions than you might out of any month's worth of town hall meetings.

In bringing those folks to the table, make clear whether their role is to be as active participants and decision-makers or simply a sounding board for decisions that have already been made. Nothing will drive those folks away from the table faster than an implied but unfulfilled promise of a meaningful voice in the process.

Remember as well that residents themselves may need to be involved and invested in the success of a smart technology initiative for it to succeed. Their disinterest in a new service delivery paradigm—even one that holds the promise of greater efficiency and substantial cost savings—could spell doom for the approach no matter how much you invest in the technology and the marketing. So, if your county hospital is planning on becoming a leader in telemedicine, for example, make sure the patients are ready to follow.

9. Who's Paying for All This?

Smart technologies are obviously not free, but they have some built-in funding options:

- **Self-funding through productivity or efficiency gains.** Is the technology going to revolutionize the way a service is provided? If so, can it be paid for up front as a technology investment, based on a predicted medium-term return on investment?
- **Up-front costs covered by grants.** This is almost as universal a wish-list item as a high school student dreaming of getting drafted by a professional sports team. While it may remain wishful thinking in most cases, smart technologies have significant **funding potential** from private sector partners, federal or state agencies, and nongovernmental organizations. Grants and loans certainly bow to economic constraints, but particularly as presidential or gubernatorial administrations transition, significant opportunities can arise as new priorities gain emphasis.
- **Up-front costs partially funded by the private sector.** Whether for public-private partnerships in revenue-generating toll roads, parking meters, or red-light cameras, this sphere has seen a great deal of activity in the past two decades. While not all of these have been without controversy, they all follow the idea of eventual payback to investors via program revenues over time.

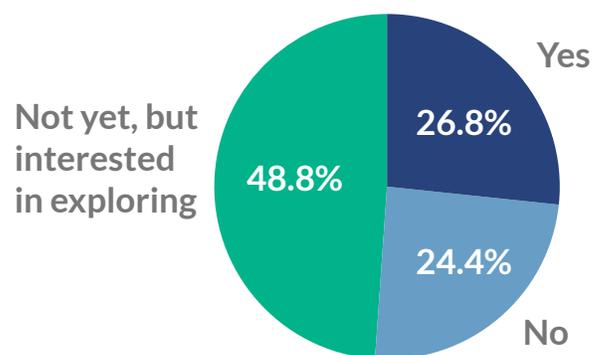
Other approaches include the investment in seed technology as a proving ground, such as with Google Fiber cities, and job-training/STEM education partnerships that benefit both the employer and the jurisdiction. If you already have local industry and education partners represented at the table in planning your smart community efforts, you may find they're not only a great source for ideas, but potentially for funding as well.

- **Up-front costs acknowledged as a public good.** Public safety improvements do not necessarily lead to decreased costs or increased revenues, but more often to improved crime-fighting strategies or decreased traffic deaths. That may even be quantifiable, such as the avoided cost of an additional incarceration. For example, the **National Highway Traffic Safety Administration's calculation of the economic cost of traffic accidents** estimates the cost to be \$242 billion (not including quality-of-life considerations for those injured or the

33,000 lives lost). Of that, direct government expenses related to accidents are \$18 billion, or a hidden tax of \$156 per household. If your initiatives are reducing the incidence of accidents at a dangerous intersection, it's worth considering how you're helping preserve your residents' lives and finances.

- **Heavy lifting done by someone else.** Not every smart community initiative has to be spearheaded by you. If the neighboring community is actively implementing a new system, the research, planning, and backbone may already be completed. If so, there may actually be a modest marginal cost to expanding that program to your jurisdiction. The same might be true even if the lead agency is not next-door, such as when a statewide RFP or cooperative purchasing arrangement might present opportunities for your jurisdiction to piggyback.
- **Shared burden.** Even where there's no single metropolitan lead agency, partnerships and consortia can be an effective way to spread the cost of smart initiatives and foster benefits for a wide swath of the public. Such was the case with the **smart permits initiative**, which brought together 33 communities in the San Francisco Bay Area for a more regional, consistent, online approach to development approval.

Does your community ever work together with other cities or counties to aggregate demand and increase purchasing power for smart city technology?



Source: 2016 Smart Cities Survey Summary Report (<https://icma.org/node/67929>) by ICMA and SCC.

- **New development.** While it's not appropriate to assess the full cost of an initiative with community-wide benefit to new development, it may be appropriate to assess

the proportionate share of those costs where specific new costs are being incurred. That was the case in Jacksonville, North Carolina, where areas requiring new traffic signals are paying to be added to the smart-signal backbone the city has already built.

- **Pay-as-you-go.** Not all smart technologies need to be implemented all at once. If that's the case for your initiative(s), you may want to phase the rollout so the cost in any one fiscal year is more manageable.

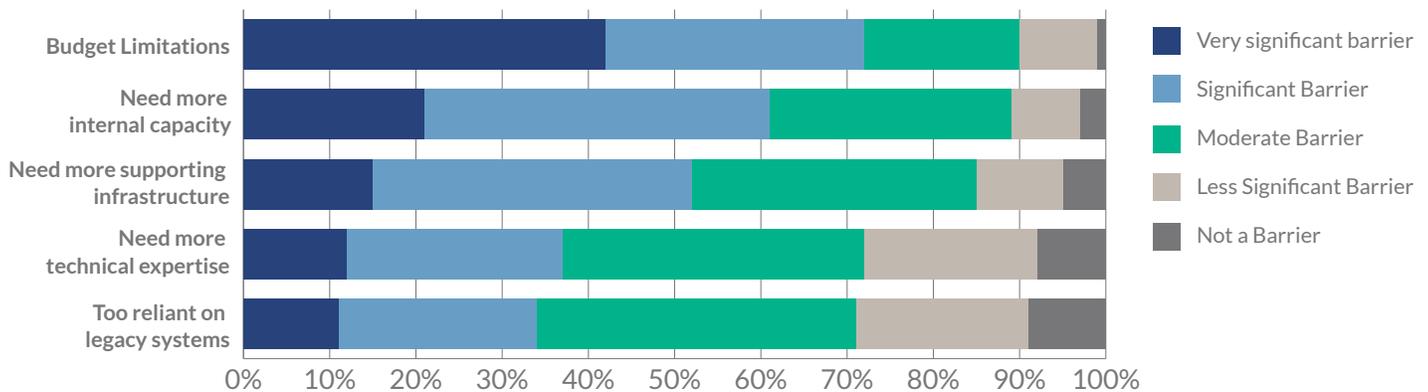
Once you've answered some of these initial questions, it's time to start putting in place the processes that will help you manage your smart community projects as they move forward.

Chapter 4

Developing a Sound Process

Approving the smart community initiative as part of your budget process is just the first step in making it a reality. The procurement itself is likewise secondary. Long-term implementation is the true challenge.

To what extent do each of the following issues represent barriers for your community to implement smart city technologies? (Check one box for each row.)



Source: 2016 Smart Cities Survey Summary by ICMA and the Smart Cities Council.

As this graph shows, budget is indeed an important consideration, but it is closely followed by the question of whether the jurisdiction has the internal capacity to manage the smart community initiatives (61.1% noted that this was a significant or very significant barrier). This is not surprising. For example, where most police administrators may excel at crime fighting, community policing, and even interjurisdictional dynamics, most are not conversant in the technical issues that go into archiving of dashboard and body camera footage, and their internal records technicians may likewise be unprepared for the challenges a new 24/7 technology poses.

Among the questions to consider are:

1. How will the effort be overseen, implemented, integrated across departments and sectors, and communicated?
2. How will the plan be integrated into the budget and updated?
3. How will the effort be evaluated and results shared?
4. How and when will the lessons learned be documented?

How Will the Effort Be Overseen, Implemented, Integrated Across Departments and Sectors, and Communicated?

Assuming you've settled on a lead department or staff person, and you've also brought all your stakeholders to the table, you now need to determine how that multi-party project will be administered:

- Will decisions be made by a single point person, by vote, or by consensus? If they are to be made by the group, will that only include jurisdiction staff, or will community representatives or private-sector partners also have a formal voice?
- Is the endorsement of the elected body needed at the program outset or only as significant appropriations or purchases are made? Even if there's no legal requirement for board/council approval, do you want to go that route to reinforce the relationship between this new initiative and expressed strategic priorities?

- What methods will you use to keep all parties informed? Will there be regular implementation meetings? Is a project management software solution appropriate?
- From an organizational perspective, do you have a history of or structure for interdepartmental teams? Particularly if there are staff to be hired, would they reside in one department or another or in a separate program-based budget? If there are revenues that would flow from the program, to which department(s) would those revenues accrue?

Even if all indications are that the program will be successful and budget pressures will not cause dissention, anticipating potential disagreements over turf issues, lines of authority, or percentage budget cutbacks will help you plan a response should issues arise.

How Will Governance and Goals Be Defined?

It can be tempting to use a cutting-edge technology to the full extent of its capabilities, but determining and communicating the boundaries can help both with your own internal planning and with your explanation of justification and controls for that new system to your local residents.

For example, if you would be deploying video surveillance or license plate reading technology:

- Who will be accountable for overseeing the use of that data?
- What will be the chain of command for accessing the information?
- What will the retention periods be?
- How would the system be treated under your state’s public records laws?
- How would sensitive/private information be protected from either accidental release or pressure from others in the organization to use it for personal or political ends?

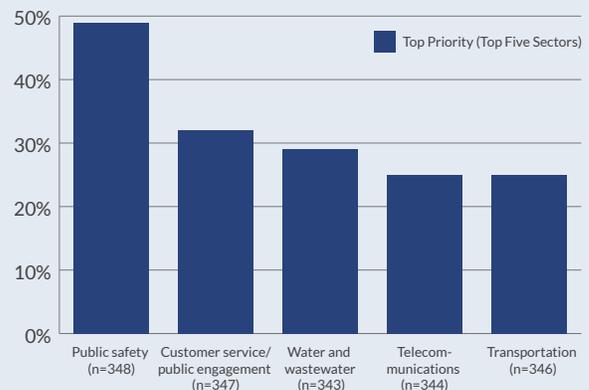
Starting with the concrete goals you want to achieve will help you to outline what uses would or would not be permitted within that scope. For example, if the purpose is to improve public safety, then the potential use of that data by social service agencies, school districts, private investigators, or marketing companies might be something you’d want to limit.

Assigning a specific individual with responsibility for oversight will limit the likelihood that a free-for-all will ensue, with no clear lines of accountability, and each department

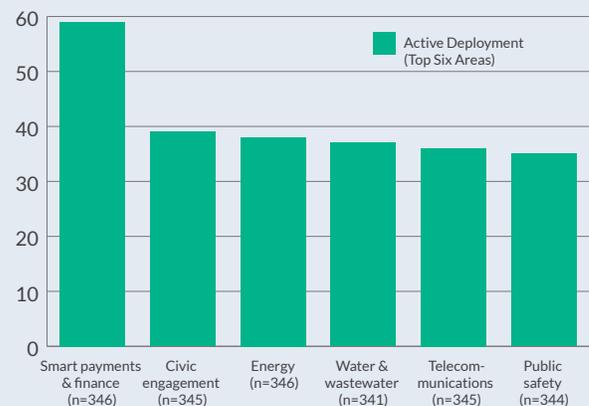
SMART CITY PRIORITIES VS. SMART CITY ENGAGEMENTS

In ICMA’s recent 2016 Smart Cities Survey, most jurisdictions indicated a priority on public safety system improvements, yet also indicated that the public safety area lags far behind other smart technologies currently being deployed, such as online payments.

For each of the following sectors, what level of priority do smart city technologies represent for your community?



What is your community’s current level of engagement with smart city technologies?



Source: Smart Cities Survey Snapshot, 2016 (<https://icma.org/node/66641>), by ICMA and SCC.

While such a lag might be expected, it points to the importance of having all affected departments involved at the planning table so that you can actually achieve your strategic priorities and integrate them with other cross-departmental opportunities at the same time.

blaming another if someone uses the system inappropriately. Your legal counsel may also advise you on administrative structures or procedures to help limit liability.

How Will the Plan Be Integrated into the Budget and Updated?

One model for a smart community implementation is the managed-competition approach. Under this model, in-house staff bid for the opportunity to provide a service, typically in competition with private vendors, such as local waste haulers or vehicle maintenance garages. This approach in essence forces you to give your budgeting for smart technology implementation the same rigor you might apply to a small business start-up.

Regardless of your approach, certain steps are critical:

- Create a business plan and a program budget.
- Report to your stakeholders or the elected officials as you might report to private investors—not with the focus being on turning a profit, but on demonstrating results across your full range of metrics.
- Don't be afraid to alter your plan as circumstances change. Remember, this is a technology initiative; you should anticipate that the latest capabilities, software, and hardware today will be **obsolete** within one to two years.
- Granted, obsolescence is in the eye of the beholder, and governments have a bit more leeway in planning their technology replacements than Fortune 500 companies. Focus on your goals, but be prepared for tech upgrades, vendor buyouts, new partners, or emerging opportunities.
- Don't assume the solution is confined to a single process. What may seem like a defense department communication technology today could be monitoring your swimming pool chemistry tomorrow. That's all the more reason not to leave implementation to an originating department operating in a vacuum. A diverse project team enables folks with different perspectives to see potential technology or service synergies that might otherwise be missed.
- Look forward... beyond both your next budget and your current strategic plan. Telecommunications company SoftBank recently made headlines around its **300-year strategic plan**, which includes eventually helping its

customers to communicate telepathically. You don't need to think that far ahead, but consider smart community strategies in every implementation decision. What will your needs and technology be in 10-20 years?

For example, in paving a street, you look at pending utility projects so you don't have surface cuts immediately after completion. But are you also considering the future wiring, sensor, or conduit needs below the road surface, such as **fiber optic infrastructure to facilitate autonomous vehicles**? As you're planning your signal systems, are you also anticipating the **end of signalized intersections**, when vehicles begin traveling more like packets of information on a network? Are you **overinvesting in downtown parking lots**? Or making decisions in building design that would limit efficient facilities management?

The old adage about measuring twice and cutting once is even more appropriate in this age when the decisions you make today could impact your ability to take advantage of smart technologies for years to come.

How Will the Effort Be Evaluated and Results Shared?

In his book **The PerformanceStat Potential**, Robert Behn talks about the essential characteristics of performance stat programs, including data, analysis, feedback, and rigorous follow-up. The focus with such programs can often be on the feedback step, which can seem to an outsider like a pile-on critique of everything the department had attempted to achieve. But as Behn emphasizes, it is the follow-up step that can be most important, as this is when the staff actually take the time to put that feedback into improving their programs and reporting back to the stakeholders as to how that revised effort has succeeded.

If a jurisdiction has a performance management program at all, it is often one that is focused around the budget—looking at the number of FTEs assigned, the number of widgets produced, and the relationship between the two. But while the budget may get “reported” to the public (at least via a web link), the performance data is seldom shared except in year-end reports, and almost never as part of a two-way dialogue about priority setting.

It doesn't have to be that way.

Since many smart community applications have a public-facing web presence already, such as a CRM home page

or a mobile app, the website is a convenient location to share dashboard-style statistics about real-time program performance. The same is true for bus shelters with “next arriving bus” message boards. Your audience would likely be impatient with the full gamut of performance data you could provide them, but a single well-placed infographic can help communicate that (a) you’re paying attention to program performance and (b) you’re doing what you can to achieve continuous improvement. Once the public is attuned to those demonstrated results, your elected officials will be much more engaged in the data-driven discussion as well.

How and When Will the Lessons Learned Be Documented?

Smart community implementations are different from most budget line items in that they are on the cutting edge of both technology and local government practice. As such, the details about their results should be widely shared so that the lessons learned can be applied by other departments in the jurisdiction, as well as by those in other jurisdictions considering the same type of approach. This also helps keep less-than-fully-successful efforts from languishing and having the same shortcomings recur.

ICMA is an active partner in such idea exchanges, whether through case studies like the ones in this e-book, sessions at ICMA’s **annual conference**, online discussions via ICMA’s website (icma.org), or **aggregation of smart city resources**. Another conference is the Smart Cities Council’s **Smart Cities Week**.

Regardless of whether you think your program is ready to be featured in such a public forum, take the time to track your metrics now, gather community feedback, and write

“

...A single well-placed infographic can help communicate that (a) you’re paying attention to program performance and (b) you’re doing what you can to achieve continuous improvement.

up the results. You may even find that the rigor you attach to that process becomes something that facilitates more in-depth consideration of future staffing or program budgeting decisions.

ICMA is also working to share data from jurisdictions concerning both the challenges and successes encountered along the path to building smart communities. For more information on topics from smart technologies to local government innovation, check out **ICMA’s survey research**. In addition, ICMA has begun to offer webinars on the topic of smart technologies and at the time of the writing of this e-book is working with the Smart Cities Council on a webinar that will highlight findings from ICMA’s smart cities survey research using examples from a variety of cities.

Next Steps

As you review the case studies in this e-book, consider the questions posed above and engage on the **icma.org “technology” topic page** (<https://icma.org/topics/technology>). We encourage you to share your story as well as your questions and resources.

Chapter 5

Smart Cities Case Studies

Critical drivers of smart communities are many, including the need to seek a solution to an existing community problem, respond to a disruptive technology, capitalize on some local advantages of hosting corporate or university research facilities, or update legacy computer systems and aging infrastructure. Perhaps the driver is simply an internal charismatic innovator acting as a change agent. Similarly, the journey into the world of smart cities is not the same for every government nor easy to uniformly duplicate because it depends on a variety of localized factors, such as organizational culture, financial capacity, and the strength of existing civic relationships between collaborative community partners.

The 13 case studies featured here reflect a continuum of technologies and enterprise-wide integration, from 311 systems and ultra-high-speed Internet connectivity to building audits and an online mapping tool used for crime prevention and data analytics. And more.

We hope that this collection of case studies will encourage readers to consider how

- smart technology can best be used to solve problems or improve service delivery and the customer experience.

- collaboration and partnerships are forceful tools for understanding complex issues and making change.
- a long-term, holistic view of the environment—especially including the community’s goals and priorities—can reveal new ways of implementing smart technologies across the organization and even across governments.

A new world of smart solutions is here today. A glance at the appendix on emerging technologies can help you identify other future technology changes that will impact your community and may require your leadership.

City of Coral Gables, Florida, Case Study

Smart Community Technologies

Located immediately adjacent to the city of Miami, Coral Gables is a medium-size city with a mix of urban and suburban character. In its smart community initiatives, it has staked out an ambitious and forward-thinking set of priorities, with the needs of local residents and businesses foremost among its considerations.

The city's assessed valuation is \$12.9 billion, driven in large part by 11 million square feet of prime office space. With a long history as a planned community, Coral Gables also incorporates green space and highly-rated walkability around its downtown and neighborhoods.

In most instances the spark for implementing smart technologies has been to improve customer experiences and improve business practices that support enhanced quality of life. The strategic plan calls for a "world-class city with a hometown feel." Project champions—whether in the manager's office, IT, finance, public works, the clerk's office, or some other part of the organization—apply that vision to maximizing both aspects of the vision, then look at the economic and technical feasibility of the related projects.

Projects and initiatives are analyzed from different angles (technology, financial, business strategy, priorities). They are discussed and reviewed with sponsors, champions, and stakeholders, especially during the budget preparation process, to identify which initiatives strategically align with the city's mission and plans and are justified so that they can be presented for funding approval.

Due diligence then includes a review of what's worked elsewhere, the track record of key vendors, the role of potential partners, and the value posed by each proposal. In addition to the university partners referenced above, the city also worked through experienced umbrella organizations where feasible. The closed-circuit television project (described under the "Public Safety Systems" section) was bid cooperatively through the U.S. Communities Purchasing Cooperative, and the mobile app development piggybacked on a procurement through the General Services Administration.

Coral Gables has adopted numerous smart city technologies to address such issues as public safety, transparent financial reporting, interactive mobile app capabilities, sea level rise monitoring and mitigation, and sustainability.

CORAL GABLES PROFILE

Population (US Census): 51,117

Land area (in square miles): 14

Median household income
(US Census): \$66,500

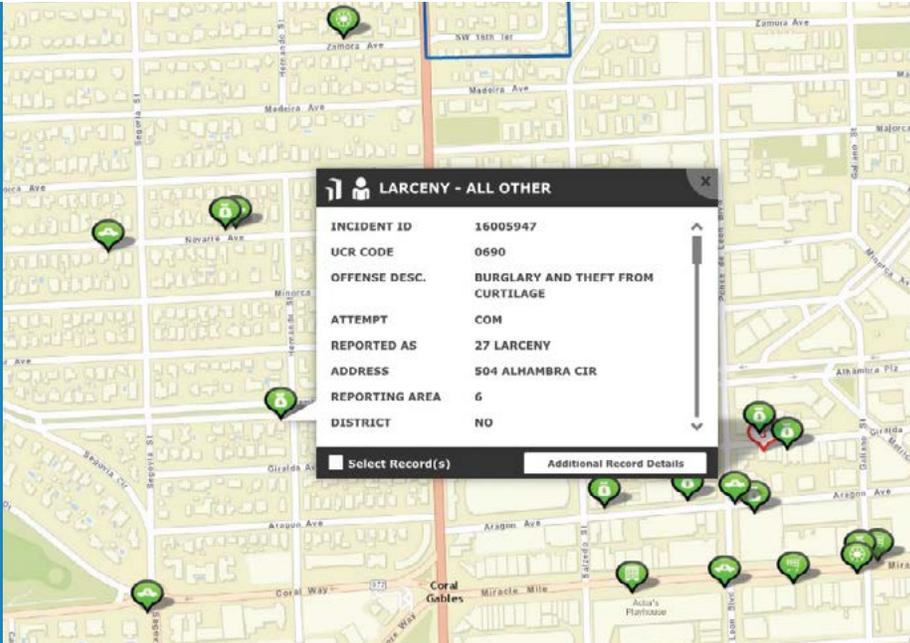
Budget (total general fund):
\$169 million

Staff FTEs (full-time employee
equivalents): 829—16 of whom
are IT staff

Major industries in the area: education
(University of Miami), tourism,
international trade, Bacardi, Del Monte

Website: www.coralgables.com

Smart technologies for: collection of
key crime data, crime data analytics,
transparent financial reporting, mobile
app and CRM, sea level rise monitoring
and mitigation, sustainability



CrimeView software allows police to analyze data visually for better investigation and crime prediction.

Public Safety Systems

Through closed-circuit television (CCTV), plate recognition software, integration with other law enforcement databases, and the creation of a Crime Intelligence Center (CIC), the city has brought online five sites around town to track all vehicles traveling through the community and to compare them to records for stolen vehicle reports, expired registrations, and active warrants. Geofencing contains that review to the city limits, while automatic alerts notify police of the location and travel direction of potentially problematic vehicles. CCTV video is also recorded and archived for potential use as evidence. Additional nodes are currently under development to ensure broad coverage of vehicles traveling through the community, such as to or from the nearby Port of Miami and Miami International Airport. Implementation of both the CCTV system and CIC began in 2015.

The resulting data supplements other law enforcement technologies, such as CrimeView and other GIS-enhanced business intelligence software, to spot trends in crime data, display that data in neighborhood heat maps, and forecast future infractions. While these systems are still in their pilot phase, they have already been used in interdepartmental strategic planning and problem-solving meetings and are providing staff and the public real-time or near-real-time access to key crime data.

Transparency

To its existing **Smart Government platform**, the city recently added a new transparency portal with OpenGov that includes an integrated cloud solution for budgeting, management reporting, and open data. With that platform, the city is working to budget more effectively, make smarter data-driven decisions, and more effectively share financial data in a way that allows the public to view, search, or drill down into city accounts.

The city will also use data analytics tied to this solution to provide links to dashboards and maps to facilitate interpretation of the city's financial performance and tie that to strategic priorities.

Mobile App

Rather than simply use its mobile app as a passive informational resource or a copy of the website, Coral Gables has strived to add **interactive**

e-government capabilities that appeal to users' needs:

- **CRM capability (through GovQA)** to submit a request, comment, or a photo of an issue and have that request get routed automatically to the appropriate department(s) based on pre-programmed business rules. The requestor can receive automatic notifications or log in to interact with the staff working on the issue.
- **ParkMe**, enables drivers to find nearby parking and check real-time garage and parking lot occupancy. This app was developed privately, and although there was a one-time customization fee for local area use, it is now cost-free to the city. A related Pay By Phone app also facilitates those parking transactions without coin-operated meters.
- **Web-interface with the ERP**, to enable permit or invoice processing.
- **Other location-based features**, which allow users to find nearby trolley stations (with work continuing on real-time GPS tracking and estimated arrival time information), parks (via the Parks305 app), and bike routes (via a partnership with Florida International University).
- **Partnerships** with the Chamber of Commerce, Business Improvement District, and University of Miami, to provide additional content and notifications.

Most of the app content has been in use since at least 2014.

Sea Level Rise Monitoring and Mitigation

With more than 42 miles of coastline and waterways, the city of Coral Gables is particularly vulnerable to the effects of climate change and sea level rise. As a result, the city has partnered with local and national universities as well as entered into a regional compact to coordinate mitigation and adaptation activities across county lines. The city also is conducting a vulnerability assessment, using SLOSH (sea, lake, and overland surges from hurricanes) modeling, and is creating an Interconnected Pond Routing storm water model.

An adaptation plan will be developed for each critical asset, based on key attributes such as technical feasibility and economic impact, and social and environmental factors.

Information technology staff have supported those efforts through the development of LIDAR risk maps (accurate to within 4 inches) and browser-based mapping linked through the public works website, supporting both internal planning efforts and public engagement.

From the public perspective, the ultimate goal is to complete a virtual reality experience to enable “immersive” exploration of potential long-term and storm-surge-related impacts.

Sustainability

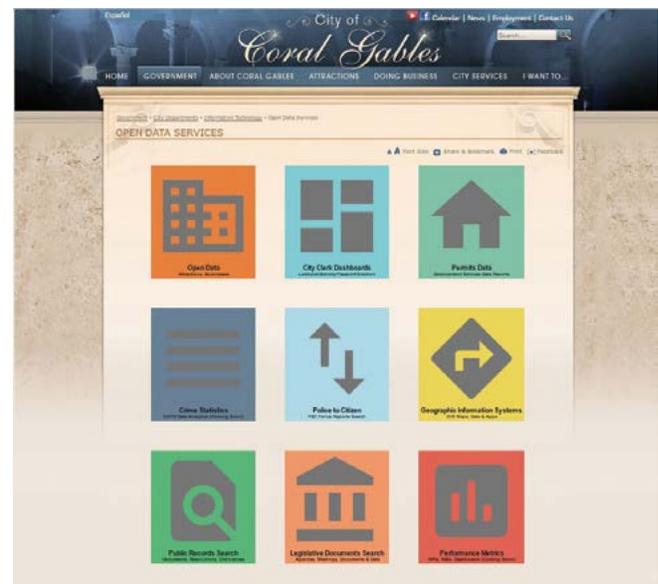
As part of its draft Sustainability Master Plan, the city is also:

- **Increasing building energy efficiency** (HVAC, LED lighting, building automation, etc.).
- **Increasing electric vehicle charging infrastructure** (nine charging stations so far).
- **Upgrading irrigation systems** to include smart weather-based controllers and flow sensors (nine systems completed in FY 2016 along major thoroughfares and in parks). Each system qualified for a \$2,850 rebate through Miami-Dade Water and Sewer and the Miami-Dade University of Florida Extension Office.
- **Exploring better management** of fleet, emissions, lighting, and renewable energy sources.
- **Requiring all new public buildings or private sector buildings over 20,000 square feet to achieve LEED Silver Green Building certification or equivalent.** Those efforts are supported in part by green bonds, with 3 percent of construction costs to be refunded to the developer if certification is completed. If certification is not achieved, the funds are retained by the city to reinvest in sustainability.

The city leadership, the community, and the stakeholders have been very supportive of these initiatives, since they have been proven beneficial for public safety, communication, citizen participation, sustainability, environmental protection, and more. A smart communities approach starts at the city’s leadership level with its vision for improvements and added value, and many times constituents themselves propose the improvements. As these initiatives render the results that were envisioned, they get more support from the constituents.

Team-based project management is also key. For example, a project committee for the CCTV/ALPR initiative includes members from public safety, IT, public works, development services, finance, and other departments and functional areas. The committee meets weekly to coordinate the work to be done, following a Scrum agile project management methodology to quickly resolve roadblocks, develop action plans, get things done on time, and achieve project scope milestones as scheduled and budgeted.

A similar methodology was followed for the city’s mobile app project, which brought together a multidisciplinary project committee with stakeholders from several departments who were involved from the early stages of the project. They evaluated different technologies and selected the solution, planned content and integration, moved forward with planning and execution stages, and tested and validated that goals were met as planned.



Open data portals provide Coral Gables residents direct access to operational details, some of it updated in real time. Photo courtesy of the city of Coral Gables, Florida

Financial Considerations

The biggest short-term costs are resource allocation and workload. Some of that workload is lessened via various partnerships or piggybacking arrangements. Long-term costs are in some cases expected to be negative thanks to efficiency improvements. For example, virtualization and cloud computing projects reduce hardware infrastructure investments. In the sustainability plan, energy efficiency investments contribute to significant cost savings in the long run, but there is a need to continually manage project phasing to better avoid short-term costs and to smooth out resource demands.

Grant funds have been a significant part of implementation, including grants for green technology, disaster recovery, and smart cities. The finance department's grant coordinator has been a key player in managing this funding. The city also recently completed a comprehensive capital improvements plan for the next 10 years which includes budgeting for technology replacement and long-term innovation.

Data Analysis and Outcomes

The city's finance department has a process to define success for any capital project to see if goals are met. Noncapital strategic action plans and projects, such as the city's Lean Six Sigma process improvement program, are evaluated against three-year milestone benchmarks.

With the mobile app, the metrics have been phased. The initial focus was around bringing value to the customer. Only as the app capabilities have been built out has the focus shifted to building community engagement. This allows for the fact that any start-up app will have a slower sign-up period until full functionality and buzz occur. While the site has a few thousand users so far, the eventual goal is for all residents and businesses to use it.

Return on investment is analyzed for several of these initiatives, and costs, revenues, and expenditure savings are forecast for the medium and long run. For example, for the energy efficiency projects, specific annual goals of percentage of reduction in energy consumption are projected over a period of 10 years. In this case, the savings come from reduction and total annual kWh consumption and applicable utility tariffs, and the reduction of costs from the implementation of the changes (e.g., LED lights retrofit, Energy Star appliances, motion sensors, HVAC automation).

Coral Gables' smart initiatives have been planned in detail and implemented on time and within budget, with minor adjustments due to unforeseen causes or new needs. A close working relationship among IT, finance, and other operating departments helps establish appropriate budgets and timelines, and define and report key performance data. In addition, the city has found that a close working relationship with outside stakeholders helps keep requirements and customer expectations in the forefront of internal planning, thus limiting later changes to the project scope.

Based on the data, staff have been able to not only share dashboard reports of their progress but also plan for post-implementation continuous improvement discussions and an assumption of quick technological obsolescence. In facility management, for example, automated controls currently being implemented will allow them to view costs per facility on a real-time basis, track current work orders, and project future maintenance.

“

Coral Gables has always included in its smart technology planning a consideration of potential risks to public safety, confidential data, business continuity, and disaster recovery.

Challenges and Concerns

Assuming stakeholder concurrence around the priorities, the critical hurdle is funding, with consideration of both the business case for undertaking a new project and consideration of the projected return on investment.

One consideration that is especially central to all smart community planning is cybersecurity. Particularly with the Internet of Things connections, Coral Gables has always included in its smart technology planning a consideration of potential risks to public safety, confidential data, business continuity, and disaster recovery. The city's partnerships with universities and industry also help it to leverage partners' considerable resources to maximize system security.

“Once the systems have been deployed, we also manage the risks of usage. All our systems and the risks to those

systems are constantly evolving,” said Raimundo Rodulfo, Interim Information Technology Director. With the range of threats in their SWOT analysis, the staff wrap cybersecurity concerns into each project’s advance planning and ongoing implementation.

Lessons Learned

One key strategy has been to learn from others before trying something for Coral Gables. Thorough research on the CCTV/ALPR project, for example, involved review of multiple case studies and site visits, which helped the city identify and mitigate potential risks.

General concept development was facilitated by participation in professional organizations and interactions with peers, such as through the Florida Local Government Information Systems Association, Institute of Electrical and Electronics Engineers, International Institute of Business Analysis, Gartner, eRepublic, and summits of chief information officers.

While there are always unpredictable circumstances, such as the actions of external regulatory agencies, Coral Gables has found that pursuing multiple concurrent projects often helps to keep overall progress on track, even if some steps along the way are occasionally slowed. The city also adheres to Project Management Institute best practices and lean management principles.

Although technology is attractive for its new and powerful features, the city has also endeavored not to pursue technology as a goal in itself, but rather to keep the customer value and needs paramount.

“ The city has endeavored not to pursue technology as a goal in itself, but rather to keep the customer value and needs paramount.

Interview Participants

All from the city of Coral Gables, Florida:

Raimundo Rodulfo, Interim Information Technology Director

Matthew R Anderson, Sustainability Specialist

Jessica A. Keller, Assistant Director of Public Works

Ayanes Apolinar, Senior Information Technology Analyst

Nelson Gonzalez, Senior Information Technology Analyst

Mark Hebert, Senior Information Technology Analyst

Lemay Ramos, Senior Information Technology Analyst

City of Olathe, Kansas, Case Study

Smart Community Technologies

The city of Olathe has been dedicated to a wide range of smart community initiatives over the past decade. The initial impetus came from a commitment to improve efficiency and increase the quality of public services. City departments were considering how technology could help them improve service delivery management and improve public engagement. Yet in that early stage, each project was considered on its own merits and was not part of any coordinated smart initiative program.

More recently, the city has begun to develop a jurisdiction-wide “Smarter City” program through the creation of a Smarter City advisory team consisting of representatives from each department. This effort provides the potential to interconnect initiatives across the entire city.

The use of advisory teams and involvement with the IT project management office will help the city organize both current and future technology initiatives while creating Olathe’s Smarter City story. The primary initiatives are identified here by core service area, with future initiatives identified under the subheading “long-term vision”:

- Public safety and security
 - » Infrastructure connecting police and fire to WiFi, cellular, or both
 - » In-car and body camera video technology and processing
 - » LPR (license plate reader) technology stationed within the city
 - » Regional records management and CAD (computer-aided design) system
 - » Citywide emergency notification system
 - » Public schools beacon safety technology
 - » *Long-term vision:* Drone technology assistance for both fire and police, and third-party Internet of Things (IoT) safety devices.
- Utility and street management
 - » AVL (automatic vehicle location) integration into online city maps
 - » Wireless meter readers and management
 - » Digital water backflow, leak detection, and Facility Operations Center monitoring

OLATHE PROFILE

Population (US Census): 134,234

Land area (in square miles): 61.74

Median household income (US Census): \$79,767

Budget (total general fund): \$99,860,462

Staff FTEs (full-time employee equivalents): 614.25

Major industries in the area: Garmin, Honeywell, Farmers Insurance

Website: OlatheKS.org

Smart technologies for: public safety; utility, street, lighting, and traffic management; digital connections to the community; smart infrastructure

- » Infrastructure asset management
- » Robot inspection and detection
- » *Long-term vision:* Participation in the energy cloud and virtual energy market for smarter buildings, infrastructure, and end user services.
- Lighting management
 - » Remote monitoring
 - » Smart asset management
 - » Smart dimming and scene setting
 - » Intelligent energy metering and billing
 - » *Long-term vision:* Every street light will have hundreds of sensors built into the light pole and fixture.
- Traffic management
 - » Camera and video management system
 - » Incident auto-detect and alert, and accident investigation
 - » Congestion and traffic trend identification
 - » Road condition monitoring
 - » Communication and traffic light preemption for public safety
 - » *Long-term vision:* Predictive intelligent traffic patterns and smart vehicle infrastructure.
- Digital connections to the community
 - » “Olathe Connect” service request system (mobile app)
- » Parks and Recreation (mobile app)
- » Trash collection reminder and information (mobile app)
- » Home improvement and building permits/process (mobile app)
- » Open data portal
- » Performance management dashboard
- » Mobile-compatible enhanced website
- » Real-time e-chat, enabling direct Q&A between the public and utility staff
- » Citizen engagement portal
- » Digital signage and messaging boards
- » *Long-term vision:* A single mobile app that gives you access to all city services including registration, payment, notification, information, and analytics (e.g., water usage tracking as well as account history or community averages).
- Smart infrastructure
 - » Electric vehicle stations
 - » WiFi in public areas
 - » Third-party infrastructure deployments (e.g., Google)
 - » Emergency and Smart City Operation Center
 - » *Long-term vision:* Monitoring of IoT third-party community devices; use of Bluetooth beacon technology.

CITY OF OLATHE – A SMARTER CITY

SMART CITY interconnects all three digitally...



Olathe is working both on smart city technology and the communication of the program goals to local residents. Photo courtesy of the city of Olathe, Kansas.

Partnerships Are Key

Google has been a significant partner in the Kansas City metropolitan area, with a regional fiber project serving local neighborhoods. Olathe is involved in that effort, along with a Google pilot project to deploy 3.5 GHz wireless technology to serve some higher-density commercial areas.

Among the city’s mobile app initiatives is one for a health and fitness program that is cosponsored by Olathe Health System and Under Armour. While that app has obvious tie-ins to the Parks and Recreation Department, the city’s long-term goal remains to have a single integrated app to access all city services.

The city of Olathe continues to invest in smart lighting infrastructure through the recent purchase of street lights from the local electric utility, Kansas City Power and Light.

The city is also part of a countywide police records management system led by Johnson County, Kansas, which is facilitating significant public safety communication and data sharing (through Niche Technology). The system is scheduled to go live at the end of 2017. This system can also be extended to connect with Kansas City, Missouri, as they are bringing the same system online.

The city of Olathe is also bringing a new digital permitting system online in 2018 to increase efficiency in processing, customer interaction, and information sharing.

Challenges and Concerns

Privacy issues are integral to many smart community implementation plans. Whether with personally identifiable information, or video footage that may capture individuals who are victims of crimes, privacy must be addressed with each project.

“The city is committed to expanding WiFi access in public spaces . . . to improve safety and service delivery.

Additional WiFi infrastructure to support these smart city initiatives is imperative for future success. The city is committed to expanding WiFi access in public spaces (parks, swimming pools, and public safety touch-down spaces) to improve safety and service delivery. In addition, FirstNet (First Responder Network Authority) has designed and built a nationwide broadband communications network for first responders. This effort is designed to provide a digital communication network across all 50 states for all first responders (law enforcement, fire, and emergency medical services) for day-to-day operations, disaster response and recovery, and securing large events.

The city of Olathe closely monitors regulatory activity and the impact on its smart community initiatives, so this too is an area that could present potential challenge.

Financial Considerations

Historically, once budgetary approval was received for a project, most of the project cost/benefit analysis focused on the benefit side of the equation—either in terms of greater efficiencies or better service to the public. With the formation of the city’s technology project management office, the goal is better tracking of implementation milestones and expenditures, along with a coordinated, big-picture consideration of all smart community initiatives.

The city has leveraged a Technology Project Fund, part of a general fund set-aside program for technology established in 2014, to fund some of the newer initiatives.

Data Analysis and Outcomes

Through the new project management office, each project is accompanied by a scoping document with success criteria to be tracked and discussed throughout implementation. That office has now been in place for more than 12 months and has a solid portfolio of metrics viewable by all departments to demonstrate where individual projects are doing well or merit additional attention.

Lessons Learned

Coordination is beneficial not just from a financial standpoint but also for day-to-day management. Olathe anticipates using its Emergency Operations Center to establish a Smart Operations Center to bring together monitoring functions for smart infrastructure, WiFi networks, digital devices on Olathe’s smart grid, and other systems that had originally been managed by individual departments.

“A lot has been accomplished by city departments,” said CIO Shawn Whitcomb, “but utilizing the smart city program provides a citywide strategy to leverage what has been completed, what is in progress, and future initiatives across the entire city to provide our community the best possible outcomes.”

Interview Participant

Shawn Whitcomb, Chief Information Officer, City of Olathe, Kansas

Summit County, Utah, Case Study

Smart Community Technologies

Summit County's interest in using technology to achieve greater energy efficiency and sustainability began in 2009. The county's largest city, Park City, is a major tourism draw with world-class ski resorts. Economically, the city depends on snow in the mountains to bring tourists to the area. Concern over climate change led Park City Tourism and a local nonprofit, Save Our Snow, to implement an education and outreach campaign dedicated to reducing global warming. Summit County leaders, also concerned with climate change, worked with community and municipal stakeholders to develop a countywide climate action plan that aligns with Park City. "Our economy is very dependent on tourism, so any moves we can take to mitigate the impact of global warming will be considered," said Ron Boyer, Summit County's director of information technology.

The Summit County council also became more conscious about its carbon footprint from a public health standpoint. Summit County's neighbor, Salt Lake County, is subject to frequent inversions in the winter, which results in some of the poorest air quality in the country. Leaders in Summit County's public health department grew concerned that over time inversion layers might also cause health problems for Summit County residents. Thus began the county's search for technology to monitor air quality.

In 2013, the council initiated the establishment of the Summit County Sustainability Office. Staff in the new office took on the effort to identify and secure appropriate technology that could help achieve council's goals for sustainability, energy efficiency, and public health. The county council began by exploring how it could make its own facilities more sustainable and functional. Cost savings was part of the equation, but reducing the county's carbon footprint was the overriding goal.

The first buildings to have the new technologies installed were in the Summit County's Justice Center Complex. The complex consists of three buildings including the sheriff's office, the judicial courts, and the jail



The Summit County Health Department's rooftop is proving to be an excellent location for a solar field. Source: Summit County, Utah. Photo courtesy of Summit County, Utah.

SUMMIT COUNTY PROFILE

Population (Utah State Tax Commission): 39,633

Land area (in square miles): 1,882

Median household income (US Census): \$90,170

Budget (total general fund): \$62,702,592

Staff FTEs (full-time employee equivalents): 302, including 9 IT staff

Major industries in the area: tourism, outdoor recreation, and entrepreneurship

Website: www.summitcounty.org

Smart technologies for: energy efficiency in government buildings (LED retrofitting, HVAC recommissioning, solar panels), sustainability, and public health/air quality monitoring

facility. The county opted to retrofit the buildings in the complex, and in the process, implemented several new energy-saving technologies to help run buildings more efficiently. These buildings were selected first for implementation because operations there run 24 hours a day/7 days a week and would have the greatest impact initially.

A complete LED lighting retrofit was conducted that replaced over 500 inefficient T-8 and metal halide lamps and installed new occupancy sensors and dimmers throughout the buildings to reduce energy usage based on occupancy and user lighting preference. The buildings' heating and air conditioning (HVAC) systems were analyzed for energy efficiency and optimal working order. Re-commissioning of the HVAC systems included boiler and chiller controls adjustments, fan coil scheduling, and fan coil valve repairs.

The domestic hot water system was also upgraded to reduce the energy usage required to heat and pump a tremendous amount of hot water to the kitchen and bathroom facilities in the jail and to the rest of the buildings in the complex. Existing pneumatic valves were replaced with direct digital controls that allow for HVAC system scheduling, sequence of operations programming, and remote maintenance capabilities to reduce on-site labor costs. After decreasing electricity usage, the county installed 688 solar panels on the roofs of the buildings to provide an estimated 22 percent of the electricity demand.

“The mechanical systems in this building demonstrate how renewable energy, efficiency, and conservation all reduce energy consumption and contribute to air quality.”

The Summit County Public Health Department building integrated a geothermal heating system to reduce heating load and a 70 kW solar system that generates 30-35 percent of the building's electricity demand. The mechanical systems in this building demonstrate how renewable energy, efficiency, and conservation all reduce energy consumption and contribute to air quality and therefore, everyone's health. At the Public Health Department, PM2 monitoring stations (continuous monitoring of ambient air quality) were installed

to monitor air quality. The department also developed a dashboard for its website to enable residents to see trends in air quality over time.

Challenges and Concerns

The county faced a few hurdles in its effort to implement new technologies for greater sustainability. Some residents pushed back county plans for solar because they felt the effort wasted precious public resources. “We didn't want to focus the conversation on ‘this will this save money’ because there is a fairly long payback on solar installations,” said Julie Booth, Summit County's public and community affairs manager. “We knew the investment would reduce maintenance and operating costs, fix a portion of the electricity costs that are otherwise increasing at a rate of approximately 3 percent per year, and further the goals of the county council. It was that long-term strategy we wanted to keep the public focused on.”

“The county council and staff truly care about air quality and energy efficiency. We want to maintain the quality of life we all enjoy here,” said Booth. County staff focused their message on leaving the world and the county a better place to live, work, and play. Although residents in certain neighborhoods in Summit County pushed back, in other neighborhoods, the effort was very well received. After considering citizen feedback overall, the county council determined that they wanted to move forward. “We've been very successful,” said Booth.

Data Analysis and Outcomes

The county hired a part-time staff member in 2016 to support the Sustainability Office's endeavors within government operations and throughout the community. This individual tracks and monitors data both pre- and post-implementation of the new technology. In particular, county leaders want to demonstrate that investments in energy efficiency technologies and renewable energy (solar PV) are working to reduce utility and maintenance costs as well as reducing greenhouse gas emissions. The new staff member compiles data and calculates trends lines that are shared both with the county council and the public. “We can show how tax dollars were spent and how cost savings have been realized,” said Booth. “For people who are concerned with climate change, we can also quantify how we avoided releasing greenhouse gas emissions using the new technologies.”

One tool the county purchased to support the cause was a software as a service (SaaS) solution, Facility Dude. The technology imports utility data and enables the county to benchmark the date that improvements were completed in order to conduct a cost-benefit analysis and verify return on investment. The energy usage data is then entered into ClearPath, a leading online software platform offered by ICLIEI to local governments for completing greenhouse gas inventories and forecasts. “This software allows the sustainability staff to quantify and report to council and the public how we’re reducing the county’s carbon footprint,” said Lisa Yoder, Summit County’s sustainability manager.

The public can also view on the county website real-time solar power generation from each of the solar PV installations. A 4.3kW system on the Utah State University Extension building owned by the county generates 90-95 percent of its electricity demand. The Public Health Department building receives one-third of its electrical supply from the sun. And as mentioned earlier, the solar PV installation on the Justice Center complex provides nearly 25 percent of its electricity usage. A single solar panel powers a water feature in front of the Public Health Department building, which offers an opportunity for school groups and visitors to experience solar energy usage by demonstrating how a hand shading the solar panel reduces the water flow.

Financial Considerations

The county undertook the costs of upgrading the Justice Center Complex on its own, but worked with several partners to secure manufacturer and utility rebates for specific energy efficiency measures as it expanded its program. Rocky Mountain Power provided a Utah Solar Incentive Program rebate in the amount of \$54,188 for the solar installation on the Justice Center Complex. Rocky Mountain’s Blue Sky Community Project Funds provided the full \$220,000 to pay for the solar installation on the Public Health Department building in 2013 and \$26,000 toward the \$29,700 required for installing a solar system on the Utah State University Extension building in 2010.

“We didn’t just focus on the county’s buildings, but also took this program out into the greater community and did rooftop solar on private homes,” said Booth. The county worked with Utah Clean Energy, a local nonprofit clean energy advocacy group, and Park City to deliver a community-led bulk purchase solar program that offered a

20 percent discount and provided direct access to a qualified solar installer. Together, the partners generated greater community participation in the Mountain Town Community Solar program. As a result of the program, 110 residents are powering their homes in part with clean renewable energy from the sun.

The county, in partnership with Park City, created and supports Summit Community Power Works (SCPW), a nonprofit organization, to secure a Georgetown University Energy Prize (**GUPE**) of \$5 million to create a cleaner, more efficient energy future. Summit County is one of 50 communities in the competition throughout the United States. Both the county and Park City dedicated funds to hire a program manager to oversee implementation of the SCPW initiatives. County staff tracked the financial resources used and the results of SCPW’s initiatives that align with county goals: engage the public to reduce energy usage and to increase the use of renewable energy. Additional funds were donated by Tesoro, Rocky Mountain Power, and a number of private contributors.

“The public needs to be educated to view sustainability as a long-term effort to balance economic decisions with environmental impacts and social welfare.”

The county did establish a review panel for the selection of technology vendors that responded to the county’s request for proposals. In addition to describing the county’s requirements for the technology, Boyer explained that he reviewed the vendor proposals to determine how the new utility tracking software would connect to the county’s IT network.

Lessons Learned

There was some skepticism about the sustainability program after it first began. Initially, utility bills continued to increase. Most of the cost increase was due to utility price hikes, weather, and additional electronic equipment being used by more employees and extended hours of operations of many government buildings—things beyond the control of the

sustainability program. Some had been expected due to start-up and other installation expenses as well as the expanded responsibilities and staff assigned to sustainability endeavors. The county and local government leaders recognize not only the cost savings but also the significant contribution that changing energy use makes toward reducing emissions known to affect human health and the atmosphere. The public needs to be educated to view sustainability as a long-term effort to balance economic decisions with environmental impacts and social welfare.

“We should have talked to more people at the outset of the program and secured more buy-in and partners. We do a good job of talking about sustainability efforts throughout the county, being mindful of the language we use to explain the various benefits so that the public can relate to what’s important to each part of the county’s population,” said Yoder. Seeking out potential partners early on in each effort is also

critical. Summit County approached sustainability as being something for the greater good, and the council held their ground despite public criticism. As a result, they have more credibility going forward with other sustainability efforts.

Booth and Yoder encourage other communities to focus on the long-term sustainability of all of their efforts, to do their own research and consider undertaking similar efforts in their own communities. “It brings you together as a community,” said Booth.

Interview Participants

Julie Booth, Public and Community Affairs Manager, Summit County, Utah

Ron Boyer, Director of Information Technology, Summit County, Utah

Lisa Yoder, Sustainability Manager, Summit County, Utah

City of Bellevue, Washington, Case Study

Smart Community Technologies

Strategic planning provides direction, guides day-to-day decision-making, and outlines measurable goals for an organization. Many local governments use strategic planning to engage citizens and develop a vision for the community's future.

In May 2014, the city of Bellevue's city council approved a 20-year vision for the city. The vision identified target areas for development and established two-year priority projects. Among the priorities established by the new plan were, for example, economic development, transportation and mobility, and high-performance government.

During that process, the council also opted to take a smart city approach to improve the city's overall quality of life and services. "We were tasked to bring a smart city strategy to the council for its consideration for inclusion in the 2017-2018 budget. Our ultimate goal for Smart City Bellevue is to achieve predictive, interoperable, and adaptive services and operations," said Chief Technology Officer Chelo Picardal. Bellevue had been looking for software solutions to some of its challenges for some time. In 2014 and in step with the council's directive, Brad Miyake, city manager, made the decision to invest in smart city technology and, working with the IT team, began to analyze city data and implement new solutions.

"The most important smart city projects under way are the dashboard, smart metering, and integrated transportation systems (ITS)," said Deputy City Manager Nathan McCommon. "On the transportation side, we are working on an ITS plan that will identify where we should go from here. Several ideas in development are traveler information in real time, parking management, and better management of smart streetlights. The city is conducting research with Microsoft and the University of Washington on a video analytic system to monitor near-miss situations at intersections. The idea is that drivers of city vehicles can use the lessons learned from near misses to modify their approach to the equipment deployed.



Monitoring street traffic with live camera feeds. Photo courtesy of the city of Bellevue, Washington.

CITY OF BELLEVUE PROFILE

Population (US Census 2014): 136,000

Land area (in square miles): 33.5

Median household income (US Census): \$94,638 in 2015

Budget (total general fund, 2017-18 biennial): \$1.5 billion

Staff FTEs (full-time employee equivalents): 1,300 including 60 in IT

Major industries in the area: high tech and retail

Website: <http://www.ci.bellevue.wa.us>

Smart technologies for: dashboard, smart metering, integrated transportation systems

“Our ultimate goal for Smart City Bellevue is to achieve predictive, interoperable, and adaptive services and operations.”

Challenges and Concerns

Two challenges of any integrated initiative are finding focus and allowing time for thoughtful decision making. Very early on in the process, the IT team understood that smart city technology was broad. The *Smart Cities Readiness Guide* (from the Smart Cities Council) describes roughly 24 different areas. “We had to decide where we wanted to focus our energy. The program had to fit our community needs. Tailoring is very important. Just because San Diego has a smart streetlight program does not necessarily mean that Bellevue should too,” said Picardal.

“It took us one year to get organized. We spent about a year discussing various approaches with our council. Internally, we spent a lot of time developing a plan that made sense for Bellevue. The culmination was the scope-of-work presentation we delivered to council in October 2016. Following that, council adopted the two-year budget for 2017-2018,” explained Picardal.

It took the team another year to complete an assessment, using Carnegie Mellon University’s Smart Cities Maturity Model and Self-Assessment Tool. Multiple versions of the tool are available to local governments. The key steps of most versions include:

1. Identify the stages, key measures, results, and actions required for cities to effectively progress toward the long-term goal of becoming a smart city.
2. Conduct a needs assessment to examine the city’s current situation and determine critical capabilities needed.
3. Help city leaders develop a common language, improve intra- and intergroup collaboration in defining and executing a smart city strategy, and promote and encourage the use of emerging technologies and smart city solutions.
4. Set goals and plan for technology, partnerships, staffing, and other related investment decisions.
5. Identify funding opportunities.

Meanwhile, the IT team continued thinking about evolving technologies and what is possible. For Smart City Bellevue, multiple departments work together to achieve improved outcomes through the analysis of real-time data that will be shared among departments and communicated to various stakeholders. This approach will provide the city greater effectiveness and efficiencies in operating individual

departments as well as communicating across departments. Through the smart use of data along with the deployment of a resident portal, Bellevue can leverage the value of all smart systems operating in the community.

“We narrowed it down to six areas where we are leveraging existing programs or systems to have a significant impact on the community. The lead departments (representing the six identified areas) are IT, transportation, public safety (fire and police), water, civic services, and planning and community development (energy and buildings). Each department has its own suite of projects it wants to accomplish that fit into the smart cities process,” said Picardal.

The city of Bellevue actively works with its neighbor, the city of Kirkland, to promote and implement smart cities solutions and strategies. By joining together, the two cities are able to achieve greater economies of scale. However, to date, other cities and towns in the region have not participated to the same degree.

Financial Considerations

One of the city’s Smart Cities Maturity Assessment tasks is to identify grants and other external funding opportunities. For example, with support of the private sector consulting firm CH2M, Bellevue received a \$75,000 grant to support the development of its dashboard project.

On the utilities side, the city conducted multiple cost-benefit analyses on automatic metering. It evaluated the cost of manual meter reading versus the cost of the new infrastructure and found that labor costs were reduced significantly and meter readings were more accurate under the new system.

For transportation, Bellevue used the initial deployment to determine delay savings. (Delay savings is calculated by multiplying the total number of vehicles times the travel time required to travel a given distance and an average hourly cost. Savings is determined by comparing previous data with results from the new system.) “We applied a per-hour cost to individual commuters to determine the return on investment to the public. There was a huge rate of return. It pays for itself on an annual basis by giving Bellevue commuters more time at work and other activities, with less stressful time spent in traffic,” said Traffic Engineering Manager Chris Long.

As for street lighting, Long offers, “We are currently evaluating street lighting. Switching from high-pressure sodium streetlights to LED is a no-brainer. The energy savings

are obvious. We are looking at managing it more, such as dimming them at certain hours of the night. We have to evaluate the cost of the hardware and manual maintenance of the software versus the energy savings of better managing street lights.”

Some measures have been harder to quantify. For example, the city wants to improve commuter choices with better traveler information, but measuring and isolating the impact of only that step could be difficult.

Data Analysis and Outcomes

With the ITS program, Bellevue has electronic communications in every traffic signal in the city. It stands apart with its adaptive signal systems. Bellevue is the first city in the state of Washington to have a 100 percent adaptive system.

The use of adaptive technology is growing rapidly, and a number of products can provide different levels of adaptive functionality. “For us, adaptive means constantly measuring the performance of an intersection in real time, and then communicating back to determine how best to run the next cycle,” explains Long.

Finally, the city’s dashboard project will provide an integrated portal with a normalized database that makes data available to the city personnel and residents. It is intended to be comprehensive and understandable. Citizens will be able to easily review how the city’s solutions are performing and what progress is being made in relationship to the council’s 20-year vision.

“ [With] the city’s dashboard project, citizens will provide an integrated portal with a normalized database that makes data available to the city personnel and residents. It is intended to be comprehensive and understandable. Citizens will be able to easily review how the city’s solutions are performing.



Installing LED bulbs in traffic signals. Photo courtesy of the city of Bellevue, Washington.

Lessons Learned

“Really think about your city’s needs. If it’s transportation, just tackle that first. But a smart city approach isn’t just one thing. It has to guide the overall approach to technology. It has to take a multi-disciplinary approach and provide a way to achieve interoperability. And governance has to align with what you are trying to achieve,” advised Picardal.

For Bellevue, the Smart Cities Maturity Assessment process proved helpful because it points out more actionable projects, investments, and partnerships. Even while the technologies will shift over time, by setting reasonable goals, your approach can evolve and respond to local government needs. In Bellevue’s experience, a smart city process should be iterative, adaptable, and able to respond to opportunities quickly. It should not be overly structured, and should not lock the organization into long-term commitments because the technologies change too quickly.

Interview Participants

Chris Long, Traffic Engineering Manager, City of Bellevue, Washington

Nathan McCommon, Deputy City Manager, City of Bellevue, Washington

Chelo Picardal, Chief Technology Officer and Chair, Community Connectivity Consortium, City of Bellevue, Washington

Ken Thompson, Director of Intelligent Water Solutions, CH2M

City of Sandy Springs, Georgia, Case Study

Smart Community Technologies

The city of Sandy Springs, Georgia, is well-known for its public-private partnership city government model. The largest deployment of this model in the United States, all general city services—other than police, fire, and the city manager’s executive team—are performed by private contractors. This model has allowed the city to foster a culture of innovation and communication to meet the high customer service expectations set by its residents. In Sandy Springs, the goal in using smart city technology is not to become the smartest city, but to provide superior customer service to residents.

“We’re continually looking for opportunities to innovate and utilize technology in order to provide a higher level of service, more responsive to meet our customers’ needs and desires,” says Sandy Springs City Manager John McDonough.

Apartment Safety Checker Map

Even when not using a public-private partnership, innovation drives new approaches to service delivery and encourages cross-department collaboration. One of the city’s most innovative smart city tools is the city’s Apartment Safety Checker Map. The tool was created through a joint effort between the Sandy Springs Police Department and the city’s communications department after McDonough tasked them with identifying apartments on the low and high ends of the crime rate spectrum.

“The [mapping] . . . ranks apartment communities based on their relative safety.

The tool provides data on the number of incidents reported within individual apartment communities and also ranks apartment communities based on their relative safety. The map was created to reduce the high volume of resident calls to the police station and city call center requesting apartment safety information, and to address high crime rates in the city’s

SANDY SPRINGS PROFILE

Population (US Census): 99,770

Land area (in square miles): 37.7

Median household income (US Census): \$59,196

Budget (total general fund): \$321 million

Staff FTEs (full-time employee equivalents): 10 local government staff + approximately 370 who work on the city’s behalf through public-private partnerships; includes 3 GIS staff

Major industries in the area: medical and biotechnology, construction, telecommunications, IT/technology

Website: [Sandy Springs Apartment Safety Checker](#); [Utility Permit Map](#)

Smart technologies for: crime prevention and reduction in apartment complexes (using ArcGIS Mapping Online software)



Sandy Spring's *Apartment Safety Checker Map* displays crime statistics for an apartment complex. High crime rates are highlighted in red, and an apartment complex that falls into the middle tier of safety is highlighted in yellow. Photo courtesy of the city of Sandy Springs, Georgia.

many Class C apartments, which make up one-third of the city's apartment complexes. Sandy Springs classifies any complex over 30 years old as Class C; the city has 25 Class C complexes with a total of 7,100 units.

The tool's utility is twofold: It provides residents new to the city the ability to examine the safety of a potential apartment and also motivates apartment complex owners to improve their properties. "Not only will people not want to live in low-ranking apartments, but low rankings will also drive the rent down," McDonough says. "Nobody wants to be at the bottom. By providing the information in a transparent way, the hope is that Class C apartment owners will work to improve their property, maybe hire a security guard or put lights outside."

The map, which is accessible to new and current residents on the city's website as part of its "**Resident Guide**," uses ArcGIS Mapping Online software and integrates data collected from property owners and the police on major crime rates at apartment complexes, including murder, rape, robbery, aggravated assault, burglary, theft, theft from vehicle, motor vehicle theft, arson and narcotics offenses, in addition to disorderly conduct, loitering, and prowling incidents. Police calls that don't result in criminal charges are not included. The software also collects information on fires and whether

the complex has sprinkler systems and on-site security. The categories reflect the information residents most requested when looking for data on a specific apartment complex.

Sharon Kraun, the city's communications director, explains that she collaborated with the police department's crime analyst to create the map. The crime analyst had access to the crime data and the ability to develop the map, while Kraun developed the front end of the tool to meet residents' needs. "We worked together to identify how to collect the data most relevant for our end users, who are our residents, and how to display that information so it made sense," she says.

The tool provides users with several different search and navigation methods. The map color codes apartments into three categories—green, yellow, and red—based on crime rate. Green represents apartments with per-unit crime rates in the lowest one-third; yellow, the middle one-third; and red, the highest one-third. Users can also download a PDF that lists the apartment complexes in order of the crimes-per-unit index. The list also provides data on the percent increase and decrease in crime per unit from the previous year.

“ The residents love [the Apartment Safety Checker Map] because they can get information on their own...”

The city turned the project around in 120 days and unveiled it at a November 1, 2016, town hall meeting where staff received feedback and took questions from city council members. Kraun says they were able to address concerns and update the map after it was launched.

"The great thing about technology is that nothing has to stay one way. Making changes is easy enough so that you can adapt things as you go along," Kraun says. "For example, we've been able to add some additional statistics that weren't included in the initial launch of the map."

Challenges and Concerns

Although the color-coding feature of the map provides a quick visual for users, some city council members have questioned if it is confusing or misleading. The color-coding system is designed to evenly distribute the apartment complexes into three groups: Instead of setting a threshold crime rate that apartment complexes need to meet to be categorized as

“Because of the city’s public-private partnership government model, data collection and analysis are integrated into many of the city’s initiatives.

“green,” the map ranks them relative to other apartments in Sandy Springs. Therefore, even if all apartment complexes have very low crime rates, those that have the highest rates will still be highlighted as red on the map because other apartment complexes have minimal crime rates, and some have none at all.

Another concern raised by the community is that the Apartment Safety Checker Map does not provide a direct comparison with the city’s overall crime rate. In a press release, Kraun explained that the crimes per-unit statistic used on the map was calculated so the city is “equitable” in ranking apartment complexes of various sizes. However, the city’s crime rates are typically calculated per person, *not* per housing unit.

Financial Considerations

The costs to implement the Apartment Safety Checker Map were minimal. No outside costs were associated with the project, since the city used internal GIS staff to develop the map. “We’ve got great GIS folks here,” Kraun says. “Besides just creating the maps for general city work, they’re always looking for ways to expand and test what they can do.”

The map, which averages about 15 users per week, has saved the city time and costs associated with the high call volume of requests for apartment safety information. Instead of sending these calls to a crime analyst, police staff can quickly redirect callers to the Apartment Safety Checker Map, where residents can then examine multiple apartments on their own time.

“The residents love it because they can get information on their own and they’re no longer dependent on having to call someone,” Kraun says. “It makes it easier for our residents because the information is there when they need it and available when they’re ready to take it in.”

Data Analysis and Outcomes

The lowest crime rate calculated by the map is zero crimes per unit, the highest is about .13 crimes per unit.

The city plans to update the map annually, unless a dramatic spike in crime occurs or new data sets are identified that can be added to accommodate users. Because the project is so new, the city has not yet collected data on the impact of the map on crime reduction. McDonough and Kraun are hopeful providing information in a transparent way will motivate apartment complex owners to take actions—which can be as simple as updating their fire alert system—to improve their ranking on the map.

The city also plans to work with its code enforcement department to conduct outreach and provide assistance to help apartment communities in the bottom safety tier improve their score.

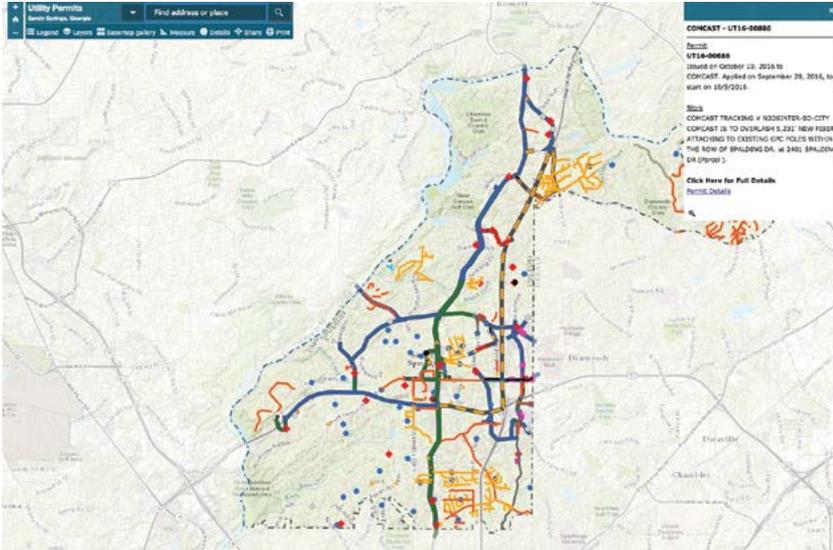
Because of the city’s public-private partnership government model, data collection and analysis are integrated into many of the city’s initiatives. McDonough explains that all of the city’s contracts mandate a certain level of key performance indicators, requiring the city to integrate data collection and analysis into many of its projects. For example, the city reports on improved travel time to measure the success of its Smart Traffic Management Center, which is run by its privately-owned public works department.

“From a management standpoint, the manager needs to narrow the indicators down to a certain number of key things that you can manage,” McDonough recommends.

Lessons Learned

The Apartment Safety Checker Map is just one testament to the success of Sandy Spring’s priority to cultivate and operate in an environment that fosters participation and innovation from the bottom up. To generate the most innovative projects, McDonough believes city managers should be open to innovation and ideas from all departments and levels of staff.

“I don’t care if you’ve only been here for six weeks, if you’ve got an idea, bring it into my office and we’ll have a meeting about it,” he says. “It’s not just senior



Information about a local utility company's permit and current project is displayed on the Sandy Springs utility permit map, which highlights various utility work that is in process or planned. Photo courtesy of the city of Sandy Springs, Georgia.

leadership bringing ideas into my office. I think it helps with communications to let people propose their ideas directly to me." McDonough uses an idea generator that allows staff from any city department to submit an idea and schedule a 30-minute meeting with him to propose the idea. When Kraun and the city's crime analyst proposed their Apartment Safety Checker Map idea to McDonough, he provided suggestions and tweaks but was largely open to their concept and ideas.

"That's sort of the genesis of ideas here—they could come from the community, from a council member, a junior staff person, or senior management," he says. Kraun adds that it is "truly a collaborative effort."

Once an idea is proposed, McDonough explains, they examine the opportunity cost. "The first question we ask is, 'How does it help us to provide better service?' The second is, 'Is it in support of our adopted priorities?'"

To help meet their customer service priority, the city has integrated mapping tools in several other areas where the city has identified a high volume of calls and concerns from residents. For instance, several utility companies are installing fiber networks throughout the community. When the city noticed a high number of residents calling in with questions

about utilities digging in their yards, the city decided to create an interactive map of current utility permits issued.

The map, which averages eight users per day, shows residents what utility company is working on their property and the length of the permit, in addition to providing contact information if residents need to report an issue.

"There wasn't a lot of communication going on between utility companies and our residents and businesses," recalls Kraun. "We are looking at tightening some of our policies, but we also realized it was an information problem. Now, any person can pull up the same data on the computer. It has reduced the number of complaint calls significantly."

Latitude from City Council

McDonough also notes that one of the city's keys to success in leveraging new projects is the latitude that city council gives to the city manager and mayor to implement new projects and ideas. As long as the ideas support the priorities adopted by the board and council, McDonough and his staff can count on city council being supportive of the idea. This reduces time spent going back and forth between elected officials, and allows the city government to quickly solve issues that pop up.

Providing Superior Customer Service

For other communities looking to improve their customer service, McDonough recommends fostering an organizational culture that places a high premium on innovation and communication. "If community service is the end goal, city managers should be willing to explore, evaluate, and resource technology to meet constituents' expectations," he says.

Interview Participants

John McDonough, City Manager, City of Sandy Springs, Georgia
Sharon Kraun, Communications Director, City of Sandy Springs, Georgia

City of Boulder, Colorado, Case Study

Smart Community Technologies

For approximately seven years the city of Boulder has embraced the use of energy performance contracting (EPC), an approach that enables local governments to secure financing for energy conservation projects and then use the subsequent energy savings to pay back the loans. It has used this approach in the areas of energy management, solar, and utilities.

Since 2010, Boulder has leveraged EPC to retrofit 66 buildings, removing energy, operational, and maintenance waste from these facilities while designing and implementing energy improvements. As a result, the city improved building performance without tapping into capital budgets. Joe Castro, facilities and fleet manager for the city, said that the city's program has been a successful strategy in its overall efforts to take meaningful climate action. "By developing realistic objectives for EPC, Boulder has realized energy savings of 20 to 40 percent in city facilities. This approach has helped the city save energy and money, and represents one of the ways Boulder has been a leader in climate action."

The city's goals at the start of the EPC were to:

- Reduce energy use, water use, and costs across all operations
- Upgrade aging infrastructure in a fiscally constrained funding environment
- Reduce GHG emissions by 20 percent
- Leverage funding opportunities through the American Recovery and Reinvestment Act of 2009, the state of Colorado, and utilities
- Improve employee comfort, workplace aesthetics, and productivity
- Incorporate renewable technology and maximize demand-side management opportunities
- Add and improve on building automation systems.

Part of a Larger Commitment

Boulder's use of EPC is just one example of a more than 20-year commitment to climate action. The effort has been enterprise-wide, using cross-departmental teams to collaboratively achieve the city's goals, which have





Solar fields in the city of Boulder. Photo courtesy of the city of Boulder, Colorado.

consistently been among the most progressive in the nation. In December 2016, the city council updated Boulder’s climate goals to reflect both what science is telling us and what the Boulder community has experienced, especially in terms of fires and flooding. The new goals are to:

- Achieve an 80 percent reduction in community greenhouse gas emissions below 2005 levels by 2050.
- Transition to 100 percent renewable electricity by 2030.
- Achieve an 80 percent reduction in city organization greenhouse gas emissions below 2008 levels by 2030.

“Boulder’s use of EPC [energy performance contracting] . . . has been enterprise-wide, using cross-department teams to collaboratively achieve the city’s goals.

Reaching these goals, both as an organization and a community, will require innovation in approach, technology, infrastructure, and financing. The fact that this is a community-wide effort is something Boulder City Manager Jane Brautigam commented on: “We are pleased with the city’s speed of adoption of this approach. It’s not just the city taking action on this front, but private citizens are also moving to solar technology and other renewable energy sources. I think we can provide a good model for other cities.”

Financial Considerations

Funding for Boulder EPC project(s) came from different sources, including a general operating account and special revenue sources. The key consideration in implementing the

EPC projects completed to date was to develop a financing package that was budget neutral every year. “The energy costs that you save should go toward the payments of whatever you financed,” Castro said. “We found our sweet spot to be 15-year financing on the portion of the program for which we had to take out a loan (\$11 million).”

Table 1. City of Boulder, Colorado, EPC Financing and Benefits

ITEM	TOTAL
Total Project Value	\$16,232,960
• Electric and Gas Utility Rebates (one time only)	(\$2,042,957)
• Energy Efficiency and Conservation Block Grant (EECBG)	(\$360,000)
• City Capital	(\$2,385,058)
Required Financing	\$11,139,262

Several items are worth noting about this financial approach:

- Stimulus funding came from EECBGs (Energy and Efficiency Conservation Block Grants; about 2 percent of funds).
- Twenty-four of 28 projects (86 percent) completed so far were awarded to contractors in Colorado, with 13 (54 percent) in the Boulder area.
- The projects have resulted in \$11.5 million to subcontractors and represent \$6 million in labor, with 422 people employed over a three-year timeframe.
- Professional staff at the energy service company increased from 14 to 35 in three years.

“Local government finance officers often struggle to find effective and fiscally prudent financing methodologies to meet resilience and sustainability goals,” Chief Financial Advisor Bob Eichen noted. “The method used by the city of Boulder for the projects in this endeavor has proven it can do both.”

Data Analysis and Outcomes

By using EPC, the city of Boulder has been able to achieve measurable results related to its facilities and other infrastructure. The following are some of the areas in which improvements were made, accompanied by quantitative data when possible:

- Lighting audit and retrofits
 - » 10,239 fixtures to be retrofit = 1,382 KW of existing lighting power
- Water conservation audit of 57 buildings and irrigation
 - » Conserving irrigation water
 - » 1,591 fixtures to adjust/modify/calibrate
- Building envelope
 - » 57 buildings audited, and weatherization completed at 43 buildings
- Solar PV at 13 locations
 - » Total output of 1,061 KW
- Solar thermal pool heating systems at two recreation centers
 - » 19,300 annual therm output
- Mechanical replacements (chillers, boilers, air handlers, etc.)
- Variable frequency drives added
- Building controls, scheduling, and optimization/re-commissioning
- Employee education and behavioral change.

Table 2. City of Boulder, Colorado, EPC Results

ITEM	TOTAL ANNUAL
Electricity reduction	7,883,532 kWh
Gas reduction	180,680 therms
Water reduction	2,796 kgals
Utility cost savings	\$667,614
Maintenance cost savings	\$52,615 (3 years only)
CO2 reduction	8,216 mtons (24.4%)
Future capital avoided	\$3,354,460 (one time)
Ongoing incentives	
• Photovoltaics (PV) renewable energy credit (REC) payments	\$97,062
• Colorado Carbon Fund payments	\$50,000 total (one time)

Challenges and Concerns

While Boulder has received international recognition for its climate action goals, the city has also faced challenges,

some of which EPC has helped address. As with many cities, variable revenues and fluctuating financial resources can make it difficult to tackle larger and more complex issues like climate action. During the 2008-09 economic downturn, some building and infrastructure projects in the city had to be postponed or re-prioritized. If not for the ability to pay back the loan over time, it is possible that these improvements would have met a similar fate. EPC provides a cost-effective path forward for cities and other governments that are committed to improving building performance, reducing energy, and saving money over time.

Lessons Learned

As with most new approaches, Boulder learned some significant lessons along the way. The following bullet points represent lessons that could be helpful to other cities considering a similar approach:

- **Be strategic about the buildings that are eligible for EPC.** “Look at the whole building and its useful life before making investments in system replacement,” Castro said. “Also keep in mind that retrofitting older buildings can be as expensive as new construction in terms of achieving energy code requirements.”
- **It helps to have clear leadership and buy-in from the top.** Boulder has a vibrant vision for addressing the impact of climate change that is supported by the city manager, by city council, and by a large majority of the community.
- **Understand that planning for EPC projects takes a different form than other types of design and build efforts.** Many construction or retrofit projects require the completion of 100 percent of the planning before any actual work begins. In contrast, the design and build phase of EPC projects typically occurs in phases. Work may begin even if only 20 to 50 percent of the final design has been completed. This approach requires more timely and collaborative communication and project management. On the plus side, it also results in flexibility to make changes on an as-needed basis. In many cases, this resulted in lower building costs than the city might otherwise have experienced.
- Some communities may be tempted to use a higher percentage of the U.S. Department of Energy’s Energy Efficiency and Conservation Block Grant (EECBG) funding than Boulder did. **Be aware that EECBG funding requires compliance with the Federal Fair Labor**

Standards Act, which establishes applicable labor rates in an area. This requirement could result in increased project construction costs because the rule applies to the full value of the combined projects, not just the individual project funded by EECBG.

- **In terms of other federal standards, Boulder ended up needing to limit the amount of recycled asphalt and concrete in its improvement efforts.** Asphalt and concrete are large sources of greenhouse gas emissions, and the Federal Highway Administration (FHWA) has established a maximum amount of recycled asphalt and concrete content that can be used in retrofitting a project.
- **Seek partnerships with other city departments that could have a role to play.** Boulder's information technology department proved to be an essential ally in helping to ensure that the technology the city was installing in its buildings worked well and met acceptable security standards.
- Lastly, familiarize yourself with any limitations to energy generation or efficiency that might be in place in your jurisdiction. In Colorado, for example, buildings can only produce enough energy to cover 120 percent of the building's historical use. While new technology could potentially achieve greater returns, your projects could be challenged if they do not conform to applicable requirements or limitations.

Looking to the Future

The EPC concept has already been a key driver of emissions reductions and energy efficiency in city-owned buildings, and as the city looks to the future, it has spurred significant conversations and innovation about how to support greener buildings throughout our community.

For instance, Boulder is currently pursuing the possible creation of its own electric utility. If successful, the city would be free from the state's regulatory structure and could lift limitations on the amount of renewable energy its buildings can generate, perhaps prompting a new round of EPC improvements. A new utility might also be able to offer on-bill financing, allowing homeowners to pay for improvements through energy cost savings, similar to the EPC concept.

Regardless of what path Boulder's energy future takes, the city has seen the benefit of strategically re-examining its infrastructure and developing creative ways to transform buildings and systems to be more sustainable.

“ The city has seen the benefit of strategically re-examining its infrastructure and developing creative ways to transform buildings and systems to be more sustainable.

Interview Participants

Jane Brautigam, City Manager, City of Boulder, Colorado

Joe Castro, Facilities and Fleet Manager, Department of Public Works, City of Boulder, Colorado

Don Ingle, Chief Information Officer, City of Boulder, Colorado

Brett KenCairn, Senior Environmental Planner, Planning, Housing & Sustainability, City of Boulder, Colorado

Bob Eichem, Chief Financial Advisor, City of Boulder, Colorado

City of Guymon, Oklahoma, Case Study

Smart Community Technology

With the phenomenal growth of the Internet, customer expectations have changed drastically. The demand for customer service is no longer confined to traditional business hours. These customer service expectations are equally true whether one lives in a small town or a large city. And local governments are increasingly expected to provide the same level of customer service as private sector businesses do. As in many communities, leaders in the city of Guymon, Oklahoma, must contend with residents' needs on a daily basis. Ultimately leaders began to look to technology for better solutions. City leaders honed in on the concept of a centralized customer service system that used smart technology to better handle contacts from community residents.

The city opted to implement a customer service-oriented smart technology known as a customer relationship management (CRM) system. Implementation of the new system took place over a three-month period, with the selected software representative and city employees working hand in glove. The software requires updating to incorporate ongoing enhancements as it is integrated with other city technologies such as GIS and IMS (Infrastructure Management Software).



Implementation of the new [CRM] system took place over a three-month period.

The Guymon Call Center functions as a 24-hours-a-day/7-days-a-week live customer support center. It is intricately coupled with software technology that enables the city of Guymon to meet the demands relative to asset management, customer requests and work orders, preventive maintenance, resources and inventory, leading practices, and regulatory compliance.

CITY OF GUYMON PROFILE

Population (US Census): 14,000

Land area (in square miles): 7.3

Median household income (US Census): \$51,023

Budget (total general fund): ~\$25 million, including ~\$443,500 IT budget

Staff FTEs (full-time employee equivalents): 84

Major industries in the area: commercial developments include ranching and farming

Website: <http://www.guymonok.org>

Smart technologies for: centralized call center with customer relationship management software system

Challenges and Concerns

Like many other cities its size, the city of Guymon faces three critical challenges: (a) the number of demands on the city management team continues to increase; (b) the complexity of delivering services rises each year; and (c) the intake of taxable income from Guymon's revenue sources has been decreasing. In responding to these challenges, city leaders realized that they needed to change how they approached customer relations and management.

"One of the biggest problems that the city of Guymon was looking to address with newer technology was the lack of customer service response to the residential and business communities. We did not have a department specifically equipped and able to handle all of the calls, questions, and needs of the community," said Guymon's Director of Local Government Solutions Don Howell. "Phone calls would come into city hall and would rarely be directed to the right person. Therefore, you would have employees in the building scrambling around trying to locate another employee. Most of the time the person calling was unable to reach the intended person and the message was seldom received." The city needed technology that would allow staff the opportunity to prioritize, organize, and communicate requests from residents and stakeholders of the community.

“ The city needed technology that would allow staff the opportunity to prioritize, organize, and communicate requests.

Howell continued, "One of the perceived hurdles before we started the call center included training and implementation of the new software and technology that accompanies the call center. Specifically, how do we train most of our employees to learn this new technology? And how would they embrace it?" Other hurdles included the integration of the call center technology and software into the existing technologies that staff knew how to use, and how to familiarize the public with how to interact with the new public face of the technology.

The challenges of the training on and implementation of the new call center technology resulted in a hands-on instructional method to learning. Guymon department directors and employees sat down with a facilitator to discuss

DELIVERING SERVICES THROUGH PUBLIC-PRIVATE PARTNERSHIPS

The nonprofit Institute for Building Technology and Safety (IBTS) was founded to provide services for the public good, with the aim of benefiting communities, governments, and the planet. Through a nonprofit public partnership (P3) with IBTS Community Services, LLC (IBTS-CS is a wholly-owned subsidiary of IBTS), local governments can provide services at a level and in a time frame not possible to achieve on their own.

In 2014, Guymon's city manager attended an event held by the Oklahoma Municipal League where she learned about IBTS's municipal service offerings. Afterward, she connected with IBTS staff and learned that they could deliver innovative municipal technology and services that would allow the city to more effectively and efficiently operate and deliver services to citizens of Guymon.

One of IBTS's objectives is to help organizations use the latest computer technology to collect data, improve efficiency, and promote accountability in all areas. When leaders of the city of Guymon expressed a desire to improve customer service to constituents, IBTS suggested bringing call center technology to the city through its private-public partnership. The Guymon Call Center was implemented by IBTS and its team of subject matter experts in three months.

the job roles and responsibilities within their departments while the facilitator took notes of the discussion. The notes from each department's employees were input into the data-driven software. Before implementation, the department's employees were given a week to interact with the technology and anticipate any issues.

Embracing the technology was effortless for younger employees, who were excited and interested in using the technology and seeing how it would save them both time and effort. The older generation of employees—usually department directors—was less interested in the technology

and more interested in how the technology would benefit their departments. Consequently, the younger generation employees embraced the technology and configured new ways to further enhance its power while the older generation consumed the information and data the technology provided so that they could provide fresh information to city leaders. A synergistic relationship between generations ensued.

Interestingly, but understandably, the public was unaware of the change until the call center technology was installed and implemented. After the implementation, the public only understood that the city of Guymon was providing them better and more efficient customer service. Call center technicians would initiate a call back to the customer after a request or complaint was handled by the assigned department. Guymon citizens, the mayor, and the city council only recognized that they were now being treated with first-class customer service priority. In essence, the Guymon public did not need to change its interaction with the city; rather, the city needed to change its interaction with those who were most important to the city—the citizens, community leaders, businesses, and all of the future stakeholders.

Financial Considerations

The largest initial decision the city had to make was whether the cost of the software and time it would take to train employees would be beneficial to the city's employees and make them more efficient and effective regarding their everyday work. Three departments—utilities, public works, and parks and recreation—receive a tremendous volume of contacts from the public. The most pressing question was whether call center technicians could, working with the new software, handle all of these community requests in a prioritized and organized manner and make work more efficient for staff.

The resulting cost savings considered for the city of Guymon includes fewer administrative assistants and receptionists to answer phones; higher productivity among field crews who do physical labor; and less waste in terms of materials and supplies. With the call center technicians handling the vast majority of public contacts, there is less need for departments to have several administrative secretaries. Call center technicians can handle most departments' work order requests and process the majority of information requests.

“The ability of the call center to answer calls, place work orders, and return calls to community residents is priceless because of the time and labor it saves each department,” said IT Director Jim Andrews.

Data Analysis and Outcomes

The city of Guymon's specific desired outcome was to become a more effective and efficient organization in terms of customer service to both residents and businesses. The council and city manager were constantly flooded with citizen requests that did not need to be addressed at the executive level, yet there was a fundamental void when it came to processes to handle the calls. These were common basic citizen requests that could be taken care of by one of the various city departments.

The community measures success by how quickly the call center technicians pick up the phone, how quickly citizens receive the information they have requested, how responsive department employees are to citizen needs, and whether citizens receive a call back letting them know the status of their request and whether the task has been completed.

The work order system software that was implemented alongside the call center generates reports that tell the exact number of calls the city received, how many work orders were received, how many of them are open (work not completed) or closed (work completed), and what progress has been made on the work. In addition, a report is issued relative to how much material was used, the labor requirements for that specific work order, in what council ward the work was performed, and what type of work was requested.

“ The data reports have allowed city officials to know the average time it takes to accomplish just about all city-provided services.

The data reports have allowed city officials to know the average time it takes to accomplish just about all city-provided services. If two employees are doing similar work, it can be determined which employee is quicker and more efficient at completing the work. The overall outcomes included a more productive workforce that saves money and reduces costs in both labor and materials.

Lessons Learned

“I would recommend the use of call center technology. The technology will provide any community immediate cost savings,” said Mayor Kim Peterson. “The U.S. has thousands of small- to medium-size jurisdictions. Smaller communities need smart technology to stay relevant and competitive. Ultimately communities without smart technology are more likely to suffer a decrease in population and, in turn, a loss in tax revenue.”

One critical lesson city leaders learned was the value of prepping employees on precisely what information would be requested from their department in order to help populate the CRM’s knowledge base. Scheduling employees to train with

the call center technology became difficult given the number of employees who needed to be trained. A training schedule would have helped staff prepare materials in advance.

The call center and its software not only make the city run more smoothly and efficiently but also encourage elected officials to be better stewards of the city.

Interview Participants

Kim Peterson, Mayor, City of Guymon, Oklahoma

Jim Andrews, IT Director, City of Guymon, Oklahoma

Don Howell, Director of Local Government Solutions, City of Guymon, Oklahoma

City of Edmonton, Alberta, Canada, Case Study

Smart Community Technologies

The city of Edmonton embraced the Open Government and Smart Cities movements early on, recognizing the benefits of data analytics in making decisions about community improvements. In 2010, city leaders began building a culture focused on data analytics by demonstrating its value through a series of projects. This citywide effort, known as the Open City Initiative, undertook the establishment of the city's Analytics Centre of Excellence (ACE). ACE has two focus areas: one is to support frontline business areas in solving real-world problems using data and advanced analytics. The other is to develop and foster an analytics culture primarily based on self-service analytics. "There is a keen appetite for advanced analytics—especially analytics for forecasting, prediction, and classification—as well as those types of technologies that employ machine learning and data mining," said Stephane Contre, chief analytics officer for the city of Edmonton.

Developed to serve the entire city government, ACE stores and maintains the city's vast catalog of electronic data and analytic capability to support informed policy development and decision making. The field of data analytics is very broad. Currently, the city has more than 400 datasets available with more data sets being created every day. These data sets are put to work to help answer key city challenges.

"We went with small but high-value initiatives at first—such as improved routing for grass and lawn maintenance (see more under "Data Analysis and Outcomes")—just to show the value of analytics and build momentum. Now we're looking at bringing multiple departments to work together as well as introducing new technology to the larger community," explained Soumya Ghosh.



The city of Edmonton is working to make data analytics an integral part of their organizational culture. Photo courtesy of the city of Edmonton, Alberta, Canada.

CITY OF EDMONTON PROFILE

Population: 899,447

Land area (in sq. miles): 270.2 square miles

Median household income: CAN\$77,490

Budget (total general fund, revenues):
CAN\$3.0 billion 2016-2018

Staff FTEs (full-time employee equivalents):
City Employees: ~11,000; IT Department = ~390; Analytics Centre of Excellence = 10

Major industries in the area: wholesale and retail trade; healthcare and social assistance; construction; professional, scientific, and technical services

Website: <http://ace.edmonton.ca> and <http://data.edmonton.ca>

Smart technologies for: crime prevention and public safety, predictive analysis, transparency (open data dashboard for the public)

Challenges and Concerns

Data analysis wasn't always politically correct. Two of the greatest challenges the city faces in building a data analytics culture involve management of stakeholders and public expectations. On the stakeholder front, department executives and managers need to understand how data analytics can benefit their departments. Those not accustomed to reviewing and analyzing data on a regular basis are often apprehensive about how results will be interpreted by higher-ups. Education and communication can help stakeholders understand that data analytics will help departments be more effective and produce better results.

From the standpoint of managing the public's expectations, it is hard to anticipate the political implications of data analytics. ACE staff push to address expectations sooner rather than later and will acknowledge when there are questions about odd correlations that the data may produce. For example, a lot of crime was occurring in downtown Edmonton, so the city started to undertake in-fill development projects to eliminate vacant properties and modernize the downtown area. In reviewing data reports over time, they found that crime rates had dropped in downtown areas where new construction occurred but had increased in surrounding neighborhoods. "The data suggested that downtown was not very safe, hence we built new projects to address those concerns. However, in taking all those steps, it now appears that surrounding neighborhoods are becoming less safe," said Ghosh.

Data Analysis and Outcomes

Enterprise-wide, Edmonton's primary outcome measure is cost savings including staffing power, transport time, and direct dollar savings. Staff also review improvements made in the delivery of services. Internally, the city is building momentum and working hard to get staff engaged in using data analytics for decision making and daily operations.

"We're looking at the projects with high visibility. Flashy projects help build a lot of momentum so people will be talking about the projects," said Ghosh. One of the first projects

“ We went with small but high-value initiatives at first . . . just to show the value of analytics and build momentum.

that put data to work is the Contextual Analysis of Crime (CAC) project. This project is one of many examples of how ACE collaborated with a front-line business area to solve a well-defined business problem. "The optimal and most cost-effective solution was the analytics approach. We have all the information available, and we gather a lot of data. Why not dig into that data and see how we can deploy it to reduce crime?" said Ghosh. Working with a cross-departmental Neighborhood Empowerment Teams, analysts identified 233 social, physical, and environmental geo-spatial factors such as litter, abandoned stolen autos, liquor stores, and graffiti. Using advanced machine learning algorithms, the team identified 92 highly significant rule sets which could have a positive or a negative influence on crime in the city. A third-party analysis shows that for every dollar the city invested in this project, the city received \$1.60 back in social returns.

“ . . . for every dollar the city invested in this project, the city received \$1.60 back in social returns.

Another project brought ACE and the city's Corporate Security team together to develop a system for proactively identifying anomalies within Corporate Security incident records and alerting advisors about unusual spikes in incident counts such as a door alarm unexpectedly being set off. The city can now detect emerging security issues and generate actionable alerts for Corporate Security advisors. As a result, human error alarms have decreased by 52 percent since the implementation of the tool.

Yet another project generating a lot of interest is developing routes for grass and lawn maintenance in the city. "We're currently working on routing optimization for the folks that cut grass across the city. They were doing it very ad hoc before and lost a lot of time traveling from point A to point B. They now work with their neighborhood branch to optimize their routing and selection of turfs, fields, and lawns they will mow on a daily basis. For the summer of 2017, we're looking at savings of about 20 percent based on the optimization that we've identified," said Contre.

Another project involves an open data dashboard. Launched in August 2016 by the Edmonton Police Service,

the dashboard gives the public on-demand access to police statistics in an easy-to-search database. The dashboard is part of the city's open data portal. Citizens use it to look up detailed information on items such as domestic violence occurrences, impaired driving incidents, traffic injury rates, police-to-population ratio, police response times, levels of crime, and disorderly conduct that are occurring in their neighborhoods and take steps to improve public safety.

Financial Considerations

The expenses associated with the effort have been minimal, primarily confined to staff labor. Approximately 10 staff members work on ACE projects on a routine basis. "FTEs are the only cost that we have," said Ghosh. "We are saving so much. The cost of this project is miniscule when compared to the savings we are building. The growth on the projects has largely been organic and has happened as people develop new ideas. One successful project generates ideas for the next successful project."

The city has invested in an enterprise license from Tableau Software that enables every city employee to access the software. The software functions much like Microsoft Windows. It is managed by the IT team, which manages the servers and all other supporting components. Everyone who works for the city and knows how to use the software can access it.

Lessons Learned

The ACE program has been quite successful, but having more than four staff members to work on projects initially would have yielded results more quickly. The city has many projects underway, and that workload does cause some concern among staff. The team committed to a number of projects all at once, making it difficult to deliver results on time. The team recommends starting with small projects first to demonstrate results quickly. The momentum will help engage stakeholders and keep staff involved.



The city of Edmonton used data analytics to create a more efficient process for scheduling mowing in the city's parks and other areas requiring clean turf. Photo courtesy of the city of Edmonton, Alberta, Canada.

"For the most part, when we think about ACE, we think in terms of technology, but when you are trying to change the culture of an organization, you need to think of it from a marketing perspective. Whatever you do, make sure you're promoting your successes really well," said Ghosh. "Change management takes time. If you have a situation where one department doesn't even talk to another about the data being collected, it makes getting started much more difficult."

The Open City initiative provided the city of Edmonton a good starting point. Introducing the city to the data available and helping staff understand how to use that data made the whole experience less intimidating. Staff learned the value of the data first, and went from there to developing new projects that are producing important results for the city.

Interview Participants

Stephane Contre, Chief Analytics Officer, City of Edmonton, Alberta, Canada

Soumya Ghosh, Director, Smart City, City of Edmonton, Alberta, Canada

City of Santa Fe, New Mexico, Case Study

Smart Community Technologies

The southwest United States is mostly low-lying desert region. It is frequently plagued with drought conditions and water comes at a premium. In the heart of this region is the city of Santa Fe, New Mexico, with the fourth largest population in the state. The supply of surface water in the Santa Fe area is not adequate for the community's long-term needs, and additional water comes from groundwater reservoirs. In the late 1990s, the city adopted a series of water use restrictions and policies, but given the level of water scarcity in the region, city leaders determined more needed to be done.

One of the measures adopted is a tiered rate system for water consumption. When a consumer hits a certain threshold, a threefold-rate increase is triggered, raising the cost from \$6.06 to \$21.72 per 1,000 gallons for residential accounts. Given the very significant difference in costs between tiers, managing water use requires access to real-time data, not monthly utility bills. "If you can't measure water use, you can't manage it," said Council Member Peter Ives.

In 2016, the city of Santa Fe decided to replace its Firefly water meter readers with new cellular-enabled Badger meters. The decades-old meters failed often and provided only monthly readings. The new meters are the largest implementation of cellular machine-to-machine (M2M) technology in the water utility sector worldwide, with 34,300 smart meters to be installed in the city.

“

Managing water use requires access to real-time data, not monthly utility bills.

The new Badger smart meters provide hourly readings providing nearly real-time data. Users can track their water consumption down to the hour and one-tenth of a gallon. The new system helps customers watch their water consumption more carefully. The system instantly notifies residents

SANTA FE PROFILE

Population (US Census): 72,113

Land area (in square miles): 37.41

Median household income (US Census): \$50,213

Budget (total general fund, revenues): \$91,789,090 (FY 2017/18)

Staff FTEs (full-time employee equivalents): ~1,590, including 30 IT staff and 360 public utilities staff

Major industries in the area: tourism and state government

Website: <https://www.santafenm.gov>

Smart technologies for: water management and conservation

and businesses if their consumption patterns have changed, alerting them to investigate a possible leak. Customers can also set up text message alerts to let them know if water has been running continuously for 24 hours. Customers have the option to view water use from their computers or smartphones.

“Users can track their water consumption down to the hour and one-tenth of a gallon.

Challenges and Concerns

The rollout of the new system went less than smoothly. During the conversion to the new Badger smart meter system, the city received numerous complaints about high water bills. Upon investigation, it was determined that during the exchange, the old drive-by meter reading system had been under reporting the consumption. Customers became upset when they were billed for water that had been consumed over the last several months to a year. This “catch up” reading caused them to be pushed to the second-tier pricing and have a high bill. Because the old meters had under-read usage for a long time, initial water bills were much higher. Many water bills ran late or were missed completely. Ultimately the new system has proven to be more accurate. While the implementation phase was plagued with problems, smart meters are widely available commercially and a proven technology that can reduce the labor and expense of doing manual meter reading. Furthermore, the technology has helped the city monitor recurring issues in the system and fix problems as they arise.

Financial Considerations

The total cost for the project was approximately \$8 million, with \$6 million spent on equipment and installation and \$2 million spent for service, software maintenance, and cell tower space for signal transmission over the 10-year contract. Nick Schiavo, Santa Fe’s public utilities director, said the city’s rates “are linked to what it costs the city to provide water,” including the water system infrastructure, water treatment, staffing, and debt service.

He said Santa Fe also has some additional costs because of the varied nature of its water supplies—two separate

well fields, city reservoirs, and the Buckman direct diversion facility, which takes water from the Southern Colorado River via the Rio Grande River, a \$220 million project for which the city split building costs 50-50 with Santa Fe County. “We could have chosen not to drill the Buckman well field or build the Buckman direct diversion, and our bills would be considerably less,” Schiavo explained. “But it would be a disservice if we couldn’t say that we’ll have water for the next 75 or so years.”

He noted that in some communities “the true cost of water is not always fully reflected in the bill.” It’s not that water bills are being subsidized, but that the cost of what’s needed in the future may not be included, Schiavo said.

Data Analysis and Outcomes

Prior to the installation of the new metering system, a monthly reading was used to determine a customer’s water bill. The new meters provide Santa Fe customers with an unprecedented level of data on water use, including when and how much water a customer consumes. Using software connected to a website, customers can track their water use and set up alerts to notify them of when they cross from tier-one pricing to tier-two pricing in their water use. Account holders can closely monitor trends in their water use and review data to see if there’s a problem. The new system also provides alerts every twelve hours via a smart phone app. Account owners can resolve any concerns they have early on and resolve issues as they arise.

“The technology has helped the city monitor recurring issues in the system and fix problems as they arise.

With the new system, the city can track gallons/person/day. As a result, the city has successfully minimized its groundwater usage. Santa Fe has one of lowest consumption ratings per person in the southwest, much lower than before new meters were installed. Santa Fe’s average daily use is 88 gallons per person per day, which is substantially lower than the national average of about 150 gallons.

Lessons Learned

While conserved water is an indirect source of water, the city leaders view it as a critical source for their long-term

water supply. The smart meter project has been less about achieving a specific metric in the city's water use and more about engaging the community in an overall effort to conserve water. "This project has been a big success on several levels. Perhaps most importantly, we have successfully created a water conservation dialogue," said Council Member Joseph Maestas. "Santa Fe has the most diverse portfolio of water resources in the Southwest now."

Interview Participants

Peter N. Ives, Council Member, City of Santa Fe, New Mexico

Joseph Maestas, Council Member, City of Santa Fe, New Mexico

Nick Schiavo, City Public Utilities and Water Division Director, City of Santa Fe, New Mexico

City of Chattanooga, Tennessee, Case Study

Smart Community Technologies

Once known as Choo-Choo Chattanooga, the city of Chattanooga, Tennessee, has made a new name for itself as the Gig City. Chattanooga is home to one of the most advanced smart grids in the nation and the fastest Internet option available in the country. Powered by an 8,000-mile fiber optic network installed by the city's municipally-owned utility, EPB Telecom, Chattanooga's smart grid and ultra-high-speed Internet have revitalized the city into a hotbed of innovation and technology.

Communitywide Fiber Optic Network

Discussions of deploying a fiber optic network began in the mid-1990s, when the city was going through a rejuvenation of the downtown area and making efforts to revitalize its economy. The mayor at the time tasked EPB's then CEO, Harold DePriest, with developing new ways EPB could benefit the community. DePriest proposed the idea of installing a fiber network to upgrade the city's electricity delivery system and worked closely with the mayor to set the plans in motion. [Chattanooga did not have a city manager or administrative position until its current mayor took office and added a chief operating officer to city staff.]

Smart grids require a "communications backbone" that can automatically respond to certain situations and make changes to the grid from the control center. "The best way to build a smart grid and 'future proof' the investment was to use the fiber optic network," explains J.Ed. Marston, EPB's vice president of marketing.

Smart Grid Problem Detection

The smart grid spans EPB's 600-square-mile territory covering Chattanooga and Hamilton County. It uses the communitywide fiber optic network to report and respond to problems in real time. The grid uses 180,000 smart meters for two-way communication. The meters automatically take remote readings every 15 minutes and allow EPB to notify customers if they detect equipment malfunction.



The community space of the Edney Innovation Center, where community members can take advantage of the Gig through a wide range of events and forums using the ultra-high-speed Internet. Photo courtesy of the Enterprise Center.

CHATTANOOGA PROFILE

Population (US Census): 173,366

Land area (in sq. miles): 140

Median household income: \$47,997

Budget (total general fund): \$230.28 million, including \$6.71 million IT budget

Staff FTEs (full-time employee equivalents): ~6,000

Major industries in the area: manufacturing, insurance, utilities

Website: <http://www.chattanooga.gov>; <http://www.theenterprisectr.org>

Smart technologies for: fiber optic network and smart grid

The smart grid also uses 1,400 of S&C Electric's IntelliRupter smart switches, which detect the exact location of faults in the lines as soon as they happen, and automatically reroute power around the faults to avoid outages.

Launching a New Business for High-Speed Internet Service

In 2000, EPB launched a telecom division to finance its electric division. The telecom division became EPB Fiber Optics in 2008, when it launched an all-fiber high-speed Internet, television, and phone bundle to residential customers. According to the Federal Communications Commission (FCC), the 2016 national median speed for fixed broadband was 39 Mbps. EPB's 1-gig service is more than 25 times faster than this, and 10 Gbps is more than 250 times faster. Today, EPB is one of only two municipally-owned Internet service providers that offer 10 Gbps Internet in the U.S., and one of only **83 publicly owned fiber-to-the-home (FTTH) networks** across the U.S., according to MuniNetworks.org.

Innovation and Digital Equity

Chattanooga has used "the Gig" as a platform to leverage innovation across the city. Current Chattanooga Mayor Andy Berke spearheaded "NoogaNet," which provides Chattanooga with free high-speed Wi-Fi access in city-owned spaces and buildings. He was also instrumental in launching EPB's NetBridge program, a partnership with Hamilton County schools that provides 100 Mbps Internet service for \$27 per month to households with children who receive free or lower priced lunches.

“Chattanooga has used “the Gig” as a platform to leverage innovation across the city.

Berke also designated an area of downtown Chattanooga as an "Innovation District," to connect and support the local entrepreneurial ecosystem. Since the launch of 1 Gbps speeds in 2010, dozens of start-ups have launched in Chattanooga in addition to a major Amazon distribution center and the first Volkswagen plant in North America.

Showcasing Possibilities

Responding to the recommendations of the city's "Technology, Gig and Entrepreneurship Task Force," Berke formed a new entity, called the Enterprise Center, to coordinate the economic development of the gigabit network and smart grid. "We were reacting to opportunities, not being proactive, so we set up an entity that had a vision for a long-term plan," explains Ken Hays, president and CEO of the Enterprise Center. The nonprofit center is working to scale up three applications for the Gig to show other cities what can be done only on smart city networks, including:

LoLa technology, a low-latency audiovisual streaming system, allows musicians at Chattanooga's public library to play live music simultaneously with musicians in Burlington, Vermont, and at the University of Southern California's Annenberg Innovation Lab. LoLa technology minimizes the streaming delay to under a millisecond.

Ultra HD (4K) technology allows students at the STEM School Chattanooga to learn about microbiology by remotely controlling a high-powered microscope at the University of Southern California.

4K video live streaming is shown on a regular basis, making Chattanooga the first place to do so. The city regularly streams animals at the Tennessee Aquarium in 4K resolution, which is also known as ultra-high-definition video and is more than double the resolution of standard "2K" high-definition video.

Challenges and Concerns

EPB's biggest setback was resistance from incumbent cable providers. Comcast waged lawsuits against EPB before they started deployment of the fiber. EPB won, but state law became an issue. The Tennessee Cable Telecommunications Association waged a lawsuit claiming EPB's business plan violated state law, and another Tennessee law has also prevented EPB from expanding its telecommunications services beyond the bounds of its electric utility service, despite requests from neighboring communities.

As more cable providers begin installing fiber in the area, Maura Sullivan, Chattanooga's chief operating officer, notes that being fair to competition—especially when a municipally-owned utility is involved—is difficult to manage. "If we get a plethora of service providers that compete with EPB for Internet and cable, it might take away from EPB's bottom line and make it harder in the future to provide as much

public access, but it's a balancing act that we've got to handle carefully to ensure other service providers have a fair chance to compete in our area," she explains.

Common challenges also include implementing communitywide initiatives and accelerating deployment of networks. To address the latter, the city is part of U.S. Ignite (see sidebar), a national networking group among 20 gigabit cities in the United States that works to create and share gigabit apps in an effort to accelerate deployment of fiber networks in more communities. As Gig applications increase, so do EPB Fiber Optic's customers. In 2016 EPB Fiber Optic's residential customers grew by 10,000, which contributed to boosting net revenue by 12.4 percent.

Financial Considerations

The smart grid and broadband networks cost approximately \$390 million to deploy. To finance the project, EPB Fiber received a \$50 million loan from EPB Electric, and EPB also issued \$229 million of local revenue bonds. In 2009, when EPB was in the process of laying out the fiber network, they were awarded a \$115.5 million federal stimulus grant from the U.S. Department of Energy to support the smart grid system. "The grant allowed us to accelerate our business plan," Marston says. "We planned to first reach 75 percent of our customers and use it to fund the rest of the deployment, but the DOE grant allowed us to reach 100 percent of our customers at once."

Hays says the major cost of the fiber optic network is installation, whereas upgrading and maintaining it is a "relatively minimal cost." EPB Fiber Optics also generates net revenue and pays about \$30 million into the electric system per year.

Data Analytics and Outcomes

The city of Chattanooga and EPB are using data to quantify the costs of the fiber optic network and to measure success. According to a 2017 study on smart grid paybacks, EPB's smart grid provides \$23.6 million in annual paybacks and revenue to the utility. In just one strong wind storm in 2012, EPB reduced customer outage time by 53 percent and saved an estimated \$1.4 million thanks to the smart grid's ability to automatically reroute power around outages.

In 2015 and 2016, the grid's smart meters saved EPB \$2.3 million in reduced meter-reading costs and cut EPB's carbon emissions by 4.7 million pounds by limiting the number of service trucks deployed for meter readings and maintenance.



EPB employees perform maintenance on Chattanooga's 8,000-mile fiber-optic network. Photo courtesy of EPB.

UPGRADING THE NATION'S GRID

Most of the country still delivers electricity using copper cables that were installed in the early 1900s, yet the nation's 21st century power needs are surpassing the capabilities of the current grid. The federal government and industry working groups have launched several initiatives and funding opportunities to help public and private electricity providers upgrade to smart grid systems. Learn more about major initiatives to upgrade the nation's grid at the following sources:

- [U.S. Department of Energy's SmartGrid.gov](#)
- [The Gridwise Alliance, a public-private initiative to transform the nation's electric power grid](#)
- [American Public Power Association on Smart Grids](#)
- [U.S. Department of Energy's Grid Modernization Initiative](#)
- [Smart Grid Investment Grant \(SGIG\) program](#)
- [The Smart Grid: An Introduction, U.S. Department of Energy Report](#)

EPB is also engaged in its own internal analysis of smart grid data to enhance reliability and troubleshoot problem areas. Marston explains that the smart grid data has been used to identify outage-prone portions of the electric system, allowing EPB to begin "under grounding" some of those power

lines. Using the data, EPB has also identified an electrical wave form that indicates when powerlines are slapping together—which puts them at great risk of damage and leads to outages—and can now address the issue before it causes an outage.

The fiber network has also had economic benefits for the city. One study estimates that EPB's fiber optic network has helped generate at least 2,800 more jobs and \$865.3 million of additional economic activity in downtown Chattanooga. "I think we've proven that there is a direct correlation between the fiber technologies and being a strong builder for the entrepreneurial community," says Hays.

U.S. IGNITE

U.S. Ignite is a public-private partnership among the nation's Gigabit communities and a range of local organizations, researchers, technology companies, entrepreneurs, and academics. In 2015, the nonprofit organization was awarded a \$6 million grant from the National Science Foundation as part of the White House efforts to support smart cities. U.S. Ignite includes 20 communities that will collaborate with the organization's private-sector partners to develop 60 next-generation applications and 200 community testbeds over the next five years.

Lessons Learned

EPB has worked closely with and consistently received full support from the mayor, city council, and business leaders on new initiatives. In turn EPB is supportive of applications for the Gig that are generated by the city. "Part of EPB's mission is to give back to the community," Sullivan says. "We have a great relationship with EPB, and they consistently work to make our ideas for the Gig become a reality."

Sullivan notes that it's important for any community to capitalize on smart city technology from an economic development standpoint to attract business and growth. "Our hook, in addition to quality of life and low cost of living, is that we also have this gig Internet. We use it as a selling point to attract businesses that need a big pipe of fiber," Sullivan explains.

NTIA'S BROADBANDUSA INITIATIVE

BroadbandUSA is a free National Telecommunication and Information Administration (NTIA) strategic initiative within the U.S. Department of Commerce to help communities across the nation further advance broadband adoption and inclusion. BroadbandUSA can provide on-the-ground technical assistance to communities that want to improve their broadband capacity and use broadband more effectively, including those looking to implement smart city solutions as part of a broadband expansion. BroadbandUSA offer a wide range of publications to help cities and counties get started in the process, including:

- Using Partnerships to Power a Smart City: A Toolkit for Local Communities
- BroadbandUSA: Introduction to Effective Public Private Partnerships
- BroadbandUSA: Guide to Federal Funding of Broadband Projects
- Planning a Community Broadband Roadmap: A Toolkit for Local and Tribal Governments

Jean Rice, senior broadband program specialist for the National Telecommunications and Information Administration's BroadbandUSA initiative (see sidebar), stresses the importance of bringing stakeholders together in the planning process to develop a solution that utilizes existing resources and addresses the economic development goals of the community. "It's easy to underestimate the importance of the planning process," she says. "From a city manager's point of view, you need to look at community needs and how broadband can best meet those. Be open to multiple solutions—there is no one-size-fits-all approach."

Consultants can also be a useful tool once the smart city technology is up and running. Chattanooga recently brought on CNX Consulting Partners to help the city through a law suit against a competing service provider. They were so helpful that Sullivan says the city is in the process of hiring a full-time consultant to help navigate right-of-way and fair competition issues long-term as EPB and competing providers continue to grow their services.



An EPB employee works on fiber optic cables extending over the Tennessee River. Photo courtesy of EPB.

“Even communities who don’t have a municipal utility can look to what Chattanooga has done to capitalize on the Gig since we’ve had it,” Sullivan says. “Today we’re continuing

to find better ways to work with the Gig, and we hope to continue expanding access to the Gig for as much of the community as we can.”

Interview Participants

Ken Hays, President and CEO, The Enterprise Center, City of Chattanooga, Tennessee

J.Ed. Marston, Vice President of Marketing, EPB, city of Chattanooga, Tennessee

Jean Rice, Senior Program Specialist, BroadbandUSA, National Telecommunications and Information Administration, Washington, D.C.

Maura Sullivan, Chief Operating Officer, City of Chattanooga, Tennessee

City of Dover, New Hampshire, Case Study

Smart Community Technologies

The city of Dover, New Hampshire, has focused on using a smart cities approach to technology since the 1990s. The city staff point to the adoption of GIS technology for planning and managing physical assets as the city's initial foray into becoming a smart city. GIS enabled the city to distribute data to workers in the field and started Dover on the path to eliminating many of its paper-based processes, which saved staff time as well as protected the integrity of the data collected in the field. The danger of field crews losing or damaging paper forms while working outside was essentially eliminated.

Other major systems that support the city's smart city strategy include a supervisory control and data acquisition (SCADA) system that allows for automated maintenance of the city's water and sewer systems and an energy management system (EMS) that staff use for managing the public facilities including the city's ice arena. Dover implemented the EMS in the late 1990s, while the SCADA system was implemented in early 2000s. According to Michael Joyal, Dover's city manager, both their SCADA and EMS systems function as "large programmable thermostats," enabling the city to stay ahead of changing conditions caused by weather.

The city also works with an enterprise work order system built on a GIS platform. City staff want to be able to respond to changing conditions by monitoring assets before an emergency arises. They note that the Internet is evolving, which enables new types of access to city systems. For example, the traffic management system captures data that is maintained in a dashboard for monitoring traffic patterns throughout the city.

City staff specifically want to integrate their work-order management systems to gather the data directly, eliminating manual processes in order to use staff for higher-level data analysis. For example, survey data on the conditions of roads and highways throughout the city has been captured for planning and capital budgeting. "Early on, we made a huge investment in GIS management and knowing our infrastructure. I think we are leaps and bounds ahead of many communities on our use of GIS for field work by our crews," said Annie Dove, Director of Information Technology.

DOVER PROFILE

Population (US Census): 30,500

Land area (in square miles): 29.03

Median household income (US Census): \$60,038

Budget (total general fund): \$135,932,509, including school department

Staff FTEs (full-time employee equivalents): 310.48

Major industries in the area: office and administrative work, manufacturing, retail, sales and related, health care, and social assistance

Website: <http://www.dover.nh.gov/>

Smart technologies for: managing physical assets (geographical information system [GIS]), automated water and sewer maintenance (supervisory control and data acquisition [SCADA] system), public facilities energy management, enterprise work order/asset management system, citizen interfaces

Development of a citizens' interface is another concern for the city. Currently the city has online forms that citizens can use to report maintenance needs, but the back end of that system is still paper-based and needs to be moved to an automated format. "We want our citizens to be able to report on and receive feedback on the assets we have," said Joyal. "We want to take advantage of the efficiencies new technology brings, from the responsiveness to environmental conditions in our buildings, water and sewer demands, and tracking history and maintenance needs of various assets throughout the city."

“Early on, [the city] made a huge investment in GIS management and knowing [its] infrastructure.

Staying Current with Technology

City staff frequently look to other communities for ideas, relying on networking to generate new ideas about how the city can use technology for better management. Professional networking has helped the city understand how things can be done differently. Department staff members routinely attend meetings and conferences to learn about developments in their field of expertise.

In many cases, the city is at the leading edge of technology when compared to its peers. For other technology, staff work closely with their vendors to insure they are getting the most out of the technology solutions they already have. Systems need to be easy to use both for staff and citizens. The intention is to get systems into the hands of employees to make their jobs easier and to insure staff are comfortable with the technology. "We don't want to create expectations we can't meet with the new systems," said Christopher Parker, Assistant City Manager: Director of Planning and Strategic Initiatives.

The city staff also consider federal and state regulations when deciding on new systems to adopt. For example, freedom of information (FOI) and right-to-know laws require that city documents be made available to the public. An electronic archive system has automated the city's process for responding to FOI requests, making it considerably easier for residents to access public information.

Challenges and Concerns

One of the challenges the city has found in adopting a smart cities strategy is finding the right niche in selecting systems. Many smart cities software solutions are designed for larger cities with larger budgets. Mid-size cities don't have the capacity or the necessary funding for such systems. At the same time, entry-level products often don't provide the sophistication needed. Within the industry, Dover staff noted that scalable solutions are hard to find. Hence the city looks to use existing software systems to that capacity and doesn't buy new all the time. For example, early work in GIS laid the foundation for a more robust asset management system for the city.

The city works closely with its vendors to insure it can realize all the benefits of a system. "There's nothing like actually using a system to test what it can do and what new capabilities it brings," said Dove. Ease of use—for both staff and citizens—is at the forefront of any training offered.

Security is a constant concern. Malicious attacks, bugs, and malware infiltrating the existing information technology (IT) systems are the subject of frequent conversations in city hall. The need for tight security is one of the reasons that the city staff have been cautious about moving to cloud-based services. While there are some applications that the city wants on the cloud such as its public library catalog, public welfare application, and public mapping system, the city makes an extra effort in its due diligence to verify that the providers have the facilities they say they have. Whenever possible, staff seek to physically verify the resources they are purchasing. Staff members make a point to secure assurances on data access and ownership for cloud-based applications. If the vendor providing the service goes out of business, how does the city recover its data? "We don't want to be left in the dark," said Parker.

“Staff members make a point to secure assurances on data access and ownership for cloud-based applications.

Financial Considerations

Costs, especially long-term costs, are another concern. Staff must weigh the costs of subscription services provided through the cloud to those of on-premise solutions that may require staff support. Among the performance metrics that staff track are: return on investment (ROI) realized from a new system, energy savings, improved efficiencies in managing operations, and freeing up staff time for higher level tasks.

The city has maintenance agreements for current solutions and critical applications. Servers are currently on a five-year rotation while hardware has support contracts. The city maintains annual renewals on software agreements. The telecommunication VOiP (voice over Internet protocol) system is updated every five years.

All IT systems and applications are tied to and must support the city's strategic plan. Staff routinely look at both outputs and outcomes to determine what has been done. For example, has the city realized improved response times or provided more accurate information? Has the city realized a reduction in traffic during rush hours?

“ All IT systems and applications are tied to and must support the city's strategic plan.

In selecting new systems, the city follows competitive procurement standards. However, city staff also conduct their own background research, interviewing past clients of vendors, speaking with their peers in the field, and learning what products vendors are offering. The city has on occasion collaborated with vendors to develop needed applications. For example, they worked with a vendor to develop an archive system that allows the city to make meeting minutes, property information, and city ordinances online for review by citizens. What were paper-based processes are now maintained in digital format.

On occasion, the city has participated in cooperative bidding to achieve economies of scale for purchasing decisions. For example, the city worked with Dover Main Street and Greater Dover Chamber of Commerce in obtaining a state of New Hampshire grant. They also worked with the cities of Portsmouth and Durham in the adoption of a parking meter solution for all three communities.

With respect to contracts for service, the city will use vendor contract templates with review by its legal counsel. Such was the case when the welfare system that had been used for 20 years had to be replaced statewide. There were fits and starts, but the city was able to share the technology with many communities.

The city team cautioned that cloud-based systems do require an extra level of due diligence primarily for security reasons. Systems that are intended for public use by citizens are more suitable for cloud-based solutions. The city has adopted cloud-based solutions for its library, public welfare services, and a public interactive map.

Data Analysis and Outcomes

In certain conditions, analysis of the data can help spot the potential for problems early, for example, plunging temperatures may result in damage to the boiler in city hall. By taking steps to prevent problems such as adjusting the thermostat, the city is better able to prevent potential problems rather than wait for a broken pipe.

At budget time, the Community Services director makes a presentation on the number of work orders that are open every month by division. If one division has more open tickets than other divisions, the case can be made for moving staff or resources within the budget. Dove noted that she can do the same type of analysis with their wireless network to determine where utilization is highest with city buildings.

“ Data analytics have proven especially useful during the city's annual budgeting process.

One of the most critical elements the city monitors is the risk of failure for certain assets. For example, tracking the age, condition, and probable risk of failure of main sewer lines can be critical. Having such data available for analysis helps establish priorities within the city's capital improvement plan.

Data analytics have proven especially useful during the city's annual budgeting process. City staff can drill down to look at annual support costs associated with a piece of equipment. Data analytics can determine staff costs associated with new technology solutions.

Data analytics have also been helpful in supporting improved energy management, with city staff able to conduct pay-back analysis for the city's capital investments. The city maintains four "buckets" of funding that are accessible for smart city technology purchases: capital investments/costs (used for perpetual licensing, software, and hardware owned by the city of Dover); technical services (cloud-based and hosted solutions); telecommunications (cellular devices and services); and maintenance. (The city defines capital investments/costs as one-time costs while maintenance, telecommunications and technical services are often recurring costs.) Initially the energy management system was part of a performance contract and was treated as a capital cost in its first year, but when the contract was expanded, it became an operating expense in subsequent years.

Dove and Parker both emphasized the need to strike a balance when selecting a smart city technology. In the search for a solution, it is easy to look to technology to solve all problems. However, an overreliance on technology can lead to greater complexity and limited sustainability. They noted that for several years Dover has used a LEAN process—a methodology that relies on a collaborative team effort to improve performance by systematically removing waste—to address the need for greater balance. The data generated through the technologies has helped the city clarify and understand how operations are working. Parker advised that cities consider a technology investment decision as a three-step process involving thinking, planning, and lastly implementation.

“ Consider a technology investment decision as a three-step process involving thinking, planning, and lastly implementation.

Joyal explained that generally the city wants technology to support rather than drive the smart city process in Dover. “We want to leverage technology to provide better and more timely services, services that are more accessible to our citizens,” said Joyal. “Having accurate and reliable data that we can depend upon makes us smarter.”

Lessons Learned

City staff hope to develop a greater and more efficient understanding of the community resources available through the technologies they have adopted. They especially hope to offer a more accessible database that will enable citizens to better understand such issues as zoning and street conditions. “It's important that we know what we have,” said Parker.

The team also noted that they are fortunate to have a wealth of talented long-term employees in the city. Much of what these employees know resides solely in their heads. The city hopes to capture that corporate knowledge and document it in the appropriate systems so that they can record and analyze municipal services in a better and more timely fashion. They also hope to push out performance metrics to understand trends in service over time.

Team members are still determining how to best use data, but initially want to report out results at a high level while developing the capacity to do deeper data dives for interested citizens. They are trying to find solutions. “We try to manage our IT technology resources on a city-wide basis because there are actual and potential linkages among the systems,” said Joyal. “For example, our computer-aided mass appraisal system was primarily used by our tax assessor but there's a tremendous amount of data in that system. By coordinating our technology resources, we can bring that data to other systems such as those for the public, police and fire, planning, and community services departments.” The intention is to examine every new application that comes into the city to determine how it fits into the larger structure of the organization.

City staff use data to understand areas where there may be shortcomings in systems and adjust operations as needed. Data analytics helps staff with both current and future planning work. Staff time to record this data is eliminated by capturing, recording, and distributing customer traffic data automatically, using both wireless and server-based technology.

Interview Participants

All from the city of Dover, New Hampshire:

Michael Joyal, City Manager

Annie Dove, Director of Information Technology

Christopher Parker, Assistant City Manager

City of Jacksonville, North Carolina, Case Study

Smart Community Technology

Home to Camp Lejeune and its related U.S. Marine Corps facilities, the city of Jacksonville is a community within a community. The military population includes 55,000 marines and sailors. While some live on base, there are roughly 30,000 active duty, family, and civilian trips each morning and evening that flow from city streets to the base and back again.

If base-related traffic was as predictable as the whistle in a long-ago factory town, traffic signals could be timed to match the typical work schedules. But unpredictability is a norm of base life. Of those assigned to the base, about 30-40 percent may be deployed at any given time. In addition, changes to work schedules base-wide or for specific groups can mean that rush hour moves forward, backward, or stretches longer than anticipated. Added to this, those entering the base need to pass through security checkpoints, which means that traffic flow off-base must be able to handle bottlenecks at the gates. Jacksonville knew it needed an integrated and automated approach to all of these related traffic issues.

Challenges and Concerns

Although each of the city's traffic signals was computer controlled, none of these were connected, and they relied on timers that could not be centrally controlled or altered. As a result, long backups were not uncommon, resulting in some drivers facing 4-6 cycles to proceed through a busy intersection. This provided both a challenge and a clear constituency in favor of a solution.

The first step in that solution was negotiation with the North Carolina Department of Transportation (NCDOT), as that agency has primary responsibility for several of the city's major roadways. To that point, changes to signalization had to be coordinated through the NCDOT office in Wilmington, located 45 minutes away.

For Jacksonville, the solution was an automated traffic management system that linked all 73 major intersections to one traffic operations center. In addition to the signal controllers, the network includes 43 TV cameras at major intersections so that supervisors gain a visual of actual conditions



Jacksonville's traffic command center allows for centralized monitoring and automated management of traffic signals in the community, as well as on the adjacent military base and unincorporated areas. Photo courtesy of the city of Jacksonville, North Carolina.

JACKSONVILLE PROFILE

Population (US Census): 84,000

Land area (in square miles): 45

Median household income (US Census): \$32,500

Budget (total general fund): \$47 million

Staff FTEs (full-time employee equivalents): 445

Major industries in the area: defense

Website: <https://jacksonvillenc.gov/index.aspx?nid=656>

Smart technologies for: automated traffic signal management system

beyond just the queueing information from in-pavement signal loop detectors.

Now, the traffic system is preprogrammed to modify signal timing patterns based on observed volumes. Signal engineering staff is notified via email and text when traffic volumes or delays exceed certain thresholds and require special attention. As there are base-related changes in traffic flow or security gate procedures, or even construction, road closures, or accidents off-base, staff can view the overall traffic network and re-program accordingly to move traffic efficiently. In routine situations, this might be as simple as activating a pre-set protocol at a different time of day (e.g., in the case of an early holiday closure). It can also be a more ad hoc reaction to developing conditions, involving multiple signals, detours, and links to electronic message board signs to communicate to drivers about any revised traffic patterns. Pending upgrades via BlueTOAD technology will allow the city to share alerts directly with affected commuters' mobile devices. And while the command center officially resides at city hall, staff can also access the system via laptop for on-the-fly adjustments even after hours.

One of the concerns the city looked to allay centered on privacy and what would be done with the video footage. To that end, they are not being used for red-light enforcement, and while they may be used for crash investigation purposes, the video is archived for only 10 days, then erased.

The system went online in the October of 2014.

Data Analysis and Outcomes

Results from this initiative can be judged on the basis of level-of-service data as well as the actions of other stakeholders. Benefits have flowed not only to base commuters but also to other city residents, transit users, and shoppers. For example, as mall traffic increases around Christmas or as the city's first Krispy Kreme donut shop opened to high customer demand, the system was able to adapt. The primary feedback from

the public has been to express support and ask why some additional intersection has not been added to the network yet.

When the program began, the only signals included were those within the city's territory. Since the results have been observed by others, the city has now also entered into agreements to manage 6 traffic signals on base, and 11 signals and 6 message board signs outside of the city limits.

Financial Considerations

NCDOT agreed to fund 75 percent of the project. Up front, that amounted to \$4 million from the state, with \$1.2 million from the city, paid for through gas tax and other general fund revenues. That initial spending covered the camera, controller, and monitoring system as well as lift trucks purchased on 5-year terms through a local bank. According to the negotiated contract terms, the city is now responsible for routine management of the signals and related labor expenses, with NCDOT reimbursing for materials. Of the \$1 million per year in ongoing costs, approximately half of that is paid by the state.

Signal controllers on Camp Lejeune have been paid for by the base.

Lessons Learned

This initiative has been led by deputy city manager through the city's department of transportation and the metropolitan planning organization's transportation director, with involvement by information technology, transit, and public safety staff as well. "We don't allow turf issues," noted city manager Richard Woodruff. In working with department heads, supervisors, or others, he emphasizes that, "You don't manage your operation, you help manage the city." Monthly meetings of all involved have helped to address issues as they've arisen.

Traffic Improvements at Major Intersections, as of May 2015

MEASURE	WESTERN BOULEVARD		LEJEUNE BOULEVARD	
	Afternoon rush hour	Weekend rush hour	Morning rush hour	Afternoon rush hour
Travel time	26%	27%	20%	4%
Delays	52%	51%	69%	15%
Stops	61%	52%	84%	38%
Fuel consumption	13%	10%	Not available	Not available

Maintenance issues have been routine, typically dealing with contractors or other construction crews snapping fiber optic lines.

“ In working with department heads, supervisors, or others, you don’t manage your operation, you help manage the city.

At this stage, more intersections are still being added to the network, with those in areas of new construction being financed by the developers. Asked of any changes he’d make,

the transportation services director noted that they are now phasing in high-definition cameras, as the costs have come down and the units offer better reliability and picture quality.

For other communities with major employment or commercial centers, staff feel their experience demonstrates the results that can be achieved through an intelligent traffic management system.

Interview Participants

Richard L. Woodruff, City Manager, City of Jacksonville, North Carolina

Anthony Prinz, Transportation Services Director, City of Jacksonville, North Carolina

City of San Diego, California, Case Study

Smart Community Technologies

Smart Cities San Diego is a multiyear collaboration combining the resources of the **City of San Diego**, **General Electric**, **University of California San Diego**, **Cleantech San Diego**, and **San Diego Gas & Electric (SDG&E)**; it is led out of the chief operating officer's office. Among other projects, this initiative has spearheaded the deployment of electric vehicle (EV) charging stations and adaptive streetlights, with a dual goal of improving sustainability and achieving more cost-effective management of the city's vehicle fueling and lighting operations. Additional efforts are in place for **real-time energy management** at Port of San Diego facilities.

Electric Vehicles

In 2009, the city received initial funding through the U.S. Department of Energy¹ to begin placing electric vehicle charging stations on city-owned properties. This was later supplemented by state grant funds, leading to activation of a total of 62 sites.

Committed to both clean technologies and smart solutions, San Diego is working toward a goal of transitioning to a city fleet that consists of 50 percent alternative fuel vehicles by the end of 2020. The goal would increase to 90 percent alternative fuel vehicles by 2035. That infrastructure provides the backbone for city vehicle charging and also begins the process of providing distributed resources to the public at destination facilities, such as the San Diego Zoo, Mission Bay, recreation centers, libraries, and beaches.

While there are now a total of 900 charging stations in SDG&E's service territory, many of those are on private property, and they are not all evenly distributed. To further bolster access, SDG&E is authorized to place as many as 3,500 charging stations throughout the area, with 10 percent of those specifically targeting economically disadvantaged communities. The utility's **Power Your Drive Program** will provide chargers for both city and public use, with an integrated smart phone app to let users know when energy supply is

SAN DIEGO PROFILE

Population (US Census): 1.39 million

Land area (in square miles): 325

Median household income (US Census): \$66,116

Budget (total general fund): \$1.3 billion

Staff FTEs (full-time employee equivalents): 11,328

Major industries in the area: technology, tourism, international trade, defense

Website: www.sandiego.gov

Smart technologies for: electric vehicle charging stations, adaptive street lights

¹ Funding support was provided through this grant to Arizona, California, Oregon, Tennessee, Texas, Washington, and the District of Columbia.



Visitors to the San Diego Zoo can now take advantage of “Solar to EV” charging stations for their electric vehicles. Photo courtesy of the city of San Diego, California.

high and when costs to charge drop below their preferred purchase threshold.

Some of the charges will come directly from the electrical grid, but the ones at the zoo are solar powered, with any excess power feeding back into the local energy supply.

When the general public uses one of these chargers, the cost is billed directly to them. There are also parking regulations in place that require a vehicle parked at a charger to be actively using that charger, and limiting charging time per vehicle to a maximum of 4 hours. To facilitate turnover in heavy-traffic areas, additional DC Fast Charging stations (not city owned) provide up to 40 miles of range for every 10 minutes of charging and can fully charge a vehicle in under 30 minutes.

“ When the general public uses of these [charging stations], the cost is billed directly to them.

Two other key access improvements undertaken by the city are efforts to streamline the permitting process for residential or business-funded charging stations and to incorporate Americans with Disabilities Act considerations

into its own siting decisions. For example, although accessible parking would typically be provided closest to a facility entrance, many facility electrical panels are at the backs of buildings, so staff has worked to balance the technical and human side of the installations to maximize accessibility.

Adaptive and Intelligent Street Lights

Starting with a pilot project of 40 adaptive streetlights in the downtown area in 2014, the city’s rollout has now grown to include 3,000 LED street lights, and retrofits are continuing with the county of San Diego, cities of Oceanside and San Marcos, and Port of San Diego. San Diego retrofits are expected to reach 75,000 lights and be completed by 2018.

Beyond providing more efficient LED bulbs, the new streetlights are managed wirelessly via **LightGrid**, adjust brightness levels for conditions, and include sensors to monitor and optimize downtown parking throughout the day. Staff can track outages, manually override brightness settings, and track energy usage per pole so that utility billing is based on actual figures rather than a flat rate. From a public safety perspective, those lights also included **ShotSpotter** technology to pinpoint locations where there is gunfire.

General Electric’s “Intelligent Environments for Cities” pulls real-time data into Predix, which facilitates data capture throughout the road right-of-way, from vehicle size and traffic

volume to the presence of bicycles and pedestrians. The city is also conducting a pilot project to manage traffic signals with integrated HD cameras. The result will be a more robust picture of how and when people, vehicles, and goods move around the community.

The Environmental Services Department and the Energy Office are leading the implementation of the street lighting project, with support from the chief operating officer's staff. In addition, regular smart city roundtables pull in directors of other key departments to ensure a broad engagement in the new technologies.

Financial Considerations

Most of the costs associated with the charging stations have been for up-front capital. This included funds from the U.S. Department of Energy (\$500,000), California Energy Commission (\$500,000), and matching contributions from the city of San Diego; OpConnect, LLC; and Saturn Electric, Inc. (\$443,774). Maintenance is provided by SDG&E for their stations or by a third-party provider, at no charge to the city.

For the streetlight project, total costs to deploy the sensor arrays around half the city are \$30 million, plus \$4-\$5 million to serve some Community Development Block Grant-eligible neighborhoods. The city is projecting energy efficiency savings of \$2.4 million per year, additional savings on maintenance, and elimination of 12,700 metric tons of carbon dioxide. Full payback is anticipated within 13 years.

Data Analysis and Outcomes

Staff are tracking how often each station is used, the duration of each charge ("plug time"), and the time and frequency of usage during a week or a particular time of year. All such data are collected for both city tracking and grant-related reporting, as well as for informing decisions about future charging station locations and city fleet vehicle conversions.

From a streetlight perspective, sensors enable a much more granular understanding of infrastructure usage patterns than a simple traffic study would, facilitating both long-term planning and real-time response, such as for emergency vehicle routing.

Challenges and Concerns

San Diego connected with other jurisdictions to research their electric vehicle charging station experiences, but faced some significant issues they hadn't anticipated.

One of the challenges faced in a technology environment is how the city positions itself as the risk taker of record and how it interacts with a changing stream of partners. In the case of the electric vehicle charging stations, the initial grant required that the city be listed as the customer of record for all electricity used. This put the city in the intermediary position of paying the initial cost, having the end user pay the utility, then having the utility reimburse the city. In some ways, this convoluted arrangement was simplified when the grant restrictions expired and the first technology partner went bankrupt. When negotiating with a new vendor to operate and maintain those charging stations, the city transferred the billing responsibility to them, so there is no longer an interim city "float" on the financial transactions.

“Data analytics have proven especially useful during the city's annual budgeting process.”

Cost estimates by the contractors were also a challenge, in that they did not reflect the full cost to connect each station to a transformer before connecting to the power grid. More accurate projections based on the specific types of installations and wiring needs would help to keep the project within budget.

Regarding sensor deployment, one of the concerns that had to be addressed was the fear associated with new monitoring technologies. To respond, the city held neighborhood demonstration events to show how the new systems could protect anonymity, improve local services, and achieve energy cost savings. The city used this opportunity to listen to the public's service needs as well. Pilot efforts have enabled thorough testing and privacy protections, which include a secure cloud provider, data storage on the edge, and robust cybersecurity measures used for all the city networks.

Lessons Learned

Rollout to individual neighborhoods did not go as smoothly as it could have. Where there might have been an expectation on the part of staff that the new facilities would be perceived as a welcome neighborhood amenity, any type of change can be a source of discontent. Some residents and business owners considered the charging stations superfluous, because

they didn't see a large number of electric vehicles in their neighborhood. Others looked at them as an encroachment on available parking for traditionally-fueled vehicles. The technology partner was originally viewed as a provider of community outreach, but the city found it needed to take a much more active hand in that process to ensure effective communication.

"The biggest resistance we've had is from people that are perceiving this as, 'Why do you need to do this? I don't own an electric vehicle, and I don't have a need,'" said Jacques Chirazi, business development manager in the Economic Development Department. "What they're not realizing is the chicken-and-the-egg effect: If you don't have the infrastructure, they're not going to buy the vehicle." This was particularly acute for the more than 50 percent of area residents who live in multi-family units, as they have only limited parking at their apartments or condominiums and may not have any nearby charging facilities. In such cases, the city was eventually successful in its outreach efforts, but if the city initially proposed 10 in a given neighborhood, the feedback from local residents might have brought that number down to 3, so as to preserve other available parking.

As more stations are located both in residential neighborhoods and commercial/entertainment destinations, the city is also working to overcome the "range anxiety" that a

prospective electric car owner feels—namely, that they would not be able to find charging facilities along their planned route. A statewide emphasis on electric vehicle technology—with a goal of 1.5 million electric vehicles on California roads by 2020—is also helping address this concern for those looking beyond their routine commutes to longer-range driving.

Formal project partners aside, the city also relied on advice from the [Clean Cities Coalition](#) and the [MetroLab Network](#) to learn from others' experiences.

"I think the big advice is to be open, early and often," said David Graham, Deputy Chief Operating Officer for Neighborhood Services. "This dance between a city and its vendors and its community is often laborious and unproductive. If people can come with open minds, good data, and an interest in a common goal, we can move past the traditional barriers that have made people say that government is slow and inefficient, and that business is money-grubbing and solely profit motivated."

Interview Participants

David Graham, City of San Diego Deputy Chief Operating Officer for Neighborhood Services

Jacques Chirazi, Business Development Manager, City of San Diego Economic Development Department

Chapter 6

Asking Smart Questions

Fascination and alarm about technology advances have always been a part of the human experience. Since 1851, nations of the industrialized world have held world's fairs to highlight and demonstrate the technology achievements of their countries. In 2016 Barcelona hosted the Smart Cities World Expo and Congress, with more than 600 cities in attendance.

The preceding 13 case studies give informative brief glimpses of the many smart solutions that cities and counties across the United States and Canada are implementing. Many more examples can be found in other countries where ICMA members are working with elected officials and mayors to lead their communities into a smarter future.

A technology-enhanced future is rapidly at hand and changing daily due to the disruptive technologies affecting our communities. With Uber announcing in April 2017 that it would be using flying vehicles in Dallas and Dubai by 2020, it isn't too soon to consider, almost surreally, how the use of flying personal vehicles might impact your community. And that's just part of the bigger question: What factors are critical to becoming a smarter community, one that can learn from and grow with emerging technology to the benefit of the community's values and quality of life?

Smart Leadership

As always, leadership is key. In *The Leadership Secrets of Steve Jobs*, the founder of Apple is quoted as saying, "Innovation distinguishes between a leader and a follower." In local government, sometimes this leadership comes in the form of an empowering vision for the use of technology as a solution to a vexing community problem. Others leaders may create a sustaining culture that fosters innovation and use of technology. And leaders may focus organizations on a specific technology issue, such as transportation signalization, or practice facilitation of simultaneous multiple efforts

“All managers will need a greater understanding of the magnitude of technology trends and analytic-based solutions, which are growing exponentially around the world.

throughout their organizations to embrace and integrate technologies to improve service delivery.

From the case studies presented in this publication, one can easily see that communities of all sizes can get “smarter.” Our smallest highlighted community—the city of Guymon, Oklahoma—has a population of only 14,000, while the largest highlighted community—San Diego—has a population of 1.39 million. The range in size helps make the point that ICMA managers and their communities of *all sizes* are at the forefront of the smart cities movement.

Managing smart cities and counties will require an informed awareness of technology, and this is a new skill set for many public administrators. Even reading about technology is not a professional focus for many managers today. All managers will need a greater understanding of the magnitude of technology trends and analytic-based solutions, which are growing exponentially around the world.

Many cities are creating centralized offices of technology and innovation, analytic dashboards of key performance indicators, and innovation hubs to shelter new start-ups and often use their products. Technology awareness and training is reflected in ICMA conference sessions, public technology and information management newsletters, and city employee participation in “innovation academies” such as those offered by the Alliance for Innovation.

Conditions Fostering Smart Solutions

A supportive community culture of elected officials, public employees, and community leaders is likely the single most important condition for success. Depending upon the scale or application of the smart technology being envisioned, the implementation may be centered in a single agency but typically requires support from elected officials and employees in potentially several agencies collaborating jointly.

Incorporation of technology solutions into strategic planning discussions and into operational assessments appears to be the best method of identifying and advancing smart technologies. Several of our case studies also recognize, however, that an operational focus of employees at all levels seeking cost savings or more effective service delivery provides the greatest source of adaptation to innovative technology. Using smart technologies to leverage limited resources is the single largest opportunity for expanding the capacity or efficiency of existing service delivery systems.

Impediments to Smart Cities

Impediments to adaptation of smart community technologies are clear. Surveys by ICMA and other organizations document that financial or budgetary limitations are frequently the chief obstacle preventing communities from effectively pursuing smarter technology and analytic-based systems. This is often the case until a technology's widespread use and marketplace competition can reduce prices enough over time to allow many jurisdictions to acquire them. But you don't always have to wait it out—innovative smart solutions can be economically pursued. Just look at the city of Las Vegas, which used a network of Amazon's Alexa intelligent personal assistants off the shelf to form an artificial intelligence prototype information system to answer citizen's questions on municipal issues and activities.

Budget constraints cause many cities to employ a strategy of either starting pilot efforts in key departments or incrementally phasing in implementation of new, comprehensive systems over time and across segments of the organization. These approaches require the organization's dedicated adherence to a long-term, executive-supported commitment to a strategic plan for rolling out technology, sometimes over years. This can result in the expensive practice of maintaining dual systems of older legacy and new infrastructure. Failure to fully implement enterprise- or community-wide systems can damage credibility for years and reduce the effectiveness of a major investment in technology.

Cybersecurity. Another major concern of public administrators reflected in ICMA's 2016 cybersecurity survey revolves around cybersecurity of both data and smart operating systems. Insecure systems can encourage white collar crime, employee sabotage, and potentially disastrous shutdowns of operational systems and infrastructure. This

potential threat increases as the technologies become more complex and integrated, and with open data accessibility. The threat also increases when proprietary off-the-shelf add-on software is incrementally used to reduce cost or supplement new features not properly designed into governmental acquisitions.

Ransomware, terrorism, and domestic or foreign hackers create weekly media stories on the nightly news which undermine the public's confidence in smart technologies. Smart communities need to take precautions to consider cybersecurity concerns in their staffing, budgeting, data policies, and strategic technology acquisitions with an eye to maintenance of the appropriate firewalls, security software upgrades, and data collection policies to protect smart systems from external and internal threats.

Offsetting the Impediments

One significant means of overcoming financial and staff limitations is the power of collaborative partnerships. Few community problems can be resolved by a single department, agency, or for that matter, by only local government. Partnership opportunities enhance a community's capacity to implement smart solutions by joining stakeholders, corporations, and agencies in strategic collaboration. Knowledgeable staffing can be shared for optimal use, and fiscal resources can be shared to assist financing smart technologies among community and government partners.



Few community problems can be resolved by a single department, agency, or for that matter, by only local government.

Smart Cities Use Data

The growing field of analytics is ushering in a new era of data-enhanced decision making. Analytics and data visualization platforms can help public administrators understand the data their agencies collect to provide insights and solve complex problems. Predictive analytics are already being used to predict future service demands and resource deployment that will enhance service delivery in cities of the future.

Smart Cities, Smart Citizens

Finally, we know government exists to serve citizens; likewise, technology in smart cities is frequently used to make government more responsive to citizens. A common goal in many communities is the use of smart technologies to improve citizen access to such services as online permitting and application processes, and to improve information distribution to enhance the customer experience and citizen participation. Citizen acceptance of technology changes and user education are equally critical elements of any technology implementation plan.



A powerful return on investment exists where smart solutions are intelligently entered into by local government, just as risk exists where they are not.

Social media platforms enable broader communication with citizens, and studies have shown income inequities are lessened where broadband exists community-wide. Social media platforms can promote democratic civic engagement, network citizens in connected communities, and improve the social cohesion among citizens in a community. Unfortunately, they can also spread misinformation, destroy confidence in government programs, and heighten civic tensions.

It's a Smart World After All

Smart communities that are built upon technologies and the integration of intelligent systems through “the Internet of Things” provide an exciting opportunity for improvement of government performance and more effective service delivery of a magnitude most of us have not experienced in our lifetime. A powerful return on investment exists where smart solutions are intelligently entered into by local government, just as risk exists where they are not. Whether technologies are implemented enterprise-wide or in scalable, financially feasible incremental solutions, local government public administrators will have a significant role to play—especially as leaders who foster a technology-savvy organizational culture. Acceptance and pursuit of the operational change

required to successfully use technologies demands a focus on employee and citizen education as well as on new skills and training for staff.

The limitations of government and the technological divide within our communities may require city and county managers to be keepers of the “holistic vision” of a smarter community and the journey required to incrementally arrive at the desired future. This will require an expanded awareness of the alternative futures that technology makes possible for smart communities. It also involves a willingness to take risks that inevitably arise when seizing opportunities to innovate, such as when incremental changes occur in legacy systems, antiquated infrastructure is replaced, and departmental systems are integrated into enterprise and community smart systems. As with the history of all technology-based change, public administrators will need to make intelligent and tough decisions that both foster smart communities and maintain democratic and community values.

Smart Questions

Smart leaders ask the right questions. These questions must fundamentally deal with the reason for a technology-driven solution and the potential impacts and benefits of the proposed introduction of smart technologies. More often overlooked and needing to be addressed are the significant public issues of data security, community equity, and solutions alignment with significant community values.

We recommend that as you address a problem or opportunity concerning emerging technologies, you begin to think about and investigate these kinds of critical questions (as well as the “Getting Started” questions of Chapter 5):

Analyzing the Problem and Process

- What is the problem my community is facing that I am a participant in solving?
- Who are the stakeholders and potential collaborators needing to be involved?
- Is solving the problem through smart technology in line with the jurisdiction's strategic plan and priorities?
- If working on a service delivery process, what are the difficulties we currently encounter?
- If I could alter the process in any way imaginable, what would make the process easier, cheaper, or better for all stakeholders?

Identifying Smart Solutions/Opportunities for Implementation

- How have other communities addressed this problem, and were there any technologies involved in the solution? What lessons can I learn from their experience?
- Who might know if there are any technologies being used to address this problem, and how could I research this?
- What technologies am I considering using, and what are their ramifications or impacts on our community? Are there negative consequences or risks? Can the technologies be implemented with equity across the community?
- What are our 5–10-year plans for systems replacement? How are we working now to incorporate smart technology and multi-stakeholder cooperation into the plans?
- How can public-private partnerships or crowdsourcing interact with technology to spur innovative approaches in service delivery?

Financial Analysis

- What are the direct and indirect costs of implementing the proposed specific smart solution?
- How will this smart technology either reduce the cost of service delivery or improve our effectiveness?
- What are the life cycle costs and ROI for the deployment of the technology?
- Does the technology positively or negatively affect existing revenue streams or present new revenue enhancement potential?
- Will the smart technology solution require changes to how we charge for the service delivery?
- If I am not sure the technology will work for my community, can I test it in a pilot to judge the product, process, or acceptability to the customer?
- If I cannot afford the smart solution in its entirety, is it possible to phase the implementation?

Operations and Maintenance Issues

- In what ways will jurisdiction and public data security be maintained?
- How could a given technology be most spectacularly hacked? Will it be innocuous, such as solitaire on a public kiosk, or something more serious, such as loss of control

for water treatment infrastructure? How are we working to mitigate the risks?

- How will we measure the success of the smart technology implementation? What options will we have to rework the implementation in response to less-than-optimum performance (either by technical or physical fixes or contractual sanctions)?

Impact Analysis of Solutions

- Have I involved the appropriate internal and external stakeholders prior to final decision making?
- How will the community (or employees) receive this technology, and what are the requirements for success?
- Does this technology strengthen and promote our corporate image and brand?
- How do the impacts of the proposed smart technology align with or strengthen cherished community values?
- Does the proposed smart technology enhance or diminish our citizens' civil rights and shared democratic community values?

Final Thoughts on Smart Technology and Leadership

Smart technologies have the potential to revolutionize the physical and economic landscapes of cities and the functioning of our communities down to the very fundamental civic relationships among our citizens. Humans will continue to interact with smartphones and computer-assisted analytics. But future communities will undoubtedly redevelop around smart grids, machines communicating with machines, and sensors to sensors within integrated automatic communication and networked systems, resulting in more efficient and sustainable communities.

As we have seen in these case studies, we stand at the brink of technological convergence that may create a new future for urban places and governmental operations. In 2016, after a mass shooting incident in Dallas, Texas, police used—possibly for the first time in the U.S.—a robotic bomb disposal device to carry a bomb into a parking facility to kill the assailant.¹ In Helsinki, Finland, a waste disposal system is now being constructed that uses pneumatic tubes to move household wastes through the community to collection centers without vehicles.² In rural Fleming, Ohio, residents are being invited to participate in a neighborhood-oriented

civic software platform from **Nextdoor**. The platform lets residents network local civic communications on everything from garage sales or bartering services to reporting suspicious vehicles on school routes. In classrooms across America a digital civic education program from iCivics on laptops teaches children about their government and how to run for elected office with entertaining video gaming technology.³

Of the many professional roles that contemporary public administrators and public leaders are challenged to assume in the smart community's future, perhaps the greatest is that of "the architect of a smarter city or community." This leadership role will require continuous awareness of the technology changes unfolding around us. Leaders will be determining with stakeholders how smart technology's deployment can benefit government service delivery and enhance the civic lives of residents.

If you still need to be convinced of the essential link between technology innovation and public service, consider the words of Bill Gates in 2013, in **his essay in Wired.com**. His inspiring article makes the case that technological advances and scientific innovations can help reduce poverty and poor health in developing countries. Gates affirms his world view, which interweaves public service and technology: "I believe that every life is valuable. That we can make things better.

That innovation is the key to a bright future. That we are just getting started."

The authors of this book believe that most public administrators will be able to wisely implement smart technologies to bring solutions to community problems and brighten the prospects of many communities. That will require asking the right questions, thinking about community systems, selecting the locally appropriate technologies, and responsibly implementing a vision of communities where, most importantly, technology serves people and the common good within our communities. The promise of a better future can be within reach.

Endnotes

- 1 "Police Use Bomb Disposal Robot to Kill a Dallas Shooting Suspect, Potentially the First Use of a Robot to Kill in American Policing, *Popular Science*, July 8, 2016.
- 2 "The Future of Waste Collection? Underground Automated Waste Conveying Systems," *Waste Management World Newsletter*, May, 15 2017.
- 3 "A Push for Civic Education," Randall Reid and Emma Humphries, *Public Management*, June 2016.

Appendix A: Technologies to Watch

Entrepreneur and philanthropist Bill Gates at Expo Milano 2015 (the most recent world's fair) in Milano, Italy, citing the use of GIS technology to track vaccination campaigns in impoverished countries, observed that 'Sometimes innovation is simple. Technology from one field is applied to another.' Public administrators are uniquely posed to observe technology—in local start-ups and corporations in their communities or while participating in international exchanges—that could have potential applications in local governments.

The following list of new technologies includes technologies that venture capitalist Chris Dixon, in a recent *Business Insider* article, identified—from self-driving vehicles to virtual reality, better food through science, and cryptocurrencies—that the private sector is already deploying but that not many local governments have used.

The diversity of the list supports the notion that what communities need even before adopting new technologies is a comprehensive plan that considers the interrelated challenges and associated solutions across the entire organization—and the implications for all parts of the organization when any one unit applies a new technology.

311/CRM Systems

Customer relationship management (CRM) systems enable local government staff to quickly provide information to residents and respond to citizen requests for service. CRM systems are often integrated with other software systems, such as GIS and asset management solutions, to ensure that service requests from citizens are addressed in a timely manner. The data reports generated by CRMs enable local government leaders to understand what service requests are being received from which neighborhoods.

Artificial Intelligence

Artificial intelligence (AI) is the term that describes a machine that mimics cognitive functions of humans. Broad-based deployment of artificial intelligence will liberate public employees from repetitive tasks, as systems learn from the increasing number of information data bases and propose solutions to complex community public safety, public health, and environmental problems.

Better Food and Potable Water Through Science

Increasing urbanization worldwide, resource scarcity, food insecurity, and community food deserts will require new forms of nutritional delivery, genetic modifications of foods, and urban food-raising technologies within building designs. Wastewater and raw water filtration technology systems will allow the use of sewer and poor source water for human consumption without fear of water borne diseases.

Broadband and the Internet of Things

Fiber optics, Wi-Fi, and broadband availability are critical issues now for individuals and communities facilitating health, education, and economic development opportunities for residents. The Internet of Things allows machine-to-machine (M2M) and sensor-to-sensor communication and transfer of data and information from household devices such as thermostats or water meters to communitywide smart grids and communitywide data bases. Complex descriptive or predictive analytics can be used on this integrated and real-time data for optimal system performance and managerial understanding and decision making.

Computerized Medicine

Improved lives and solutions for community health improvements will be enhanced through analytics of health data generated from genetic research, research analytics on diseases and epidemiology, and mobility improvements, from automated prosthetic limbs and artificial organs to telemedicine and portable **medical testing equipment inspired by Star Trek**.

Cryptocurrencies and Blockchains

These new, more secure linked Internet protocols establish economic platforms for transactions and can revolutionize procurement, taxation, and fiscal monitoring for accountability. While commonly associated with bitcoin and international finance, these technologies facilitate a next generation of PayPal-like transaction-processing security.

Dashboards

Dashboards provide business intelligence on the status of pre-defined metrics and key performance outcomes. By consolidating data into a visual format, officials can monitor and respond to changing conditions. Graphics can be directly linked to related data sources and facilitate quarterly, monthly, or more frequent snapshots or reviews. Dashboards are also an effective and transparent mechanism for communicating data to the public.

Drones and Flying Vehicles

Civilian and governmental applications will revolutionize inspection services, public safety, and environmental monitoring processes; direct delivery of goods and services; and provide future transport of employees and citizens. Flying vehicles can further reduce ground congestion, aid in delivery of services, and provide medical emergency transport. Coastal communities, for example, have started using drones to improve public safety, distribute lifesaving devices, and track the location of individual swimmers or sharks in the coastal water.

GIS

GIS (geographic information systems) technology allows users to visualize, question, analyze, and interpret spatial data to better understand locational relationships, patterns, and trends. 3D GIS adds great depth and visual perception to a map and is often used to help understand how information on diverse factors, such as populations densities, natural habits, or watersheds, might impact a proposed residential development projects.

High-Quality Remote Learning

Governmental training and community education can be dramatically improved through high-quality, remote learning technologies and enhance peer knowledge exchanges among governmental jurisdictions worldwide. Courses can be available on-demand (e.g., TED Talks, Khan Academy) or provide live access to instructors at accredited institutions (e.g., through MOOCs—massive open online courses). More importantly, essential content can be shared with a geographically distributed audience in multiple languages, with self-paced curriculum and options for tracking completion rates.

SMART CITY COLLABORATION: DUBLIN, OHIO, DEMONSTRATION PROJECT

An example of smart city collaboration is happening in the city of Dublin, Ohio, a midwestern smart community and suburb of Columbus, Ohio. Dublin is partnering in collaboration with a local council of governments and with surrounding city and county governments, Ohio State University, Battelle Memorial Institute, the state of Ohio, and Honda Corporation to implement a fiber optics network along the NW Route 33 Innovation Corridor near Columbus, Ohio.

This project will use sensors and advanced analytics to enhance existing and developing connected smart transportation grids and enable autonomous vehicle use by linking several innovation hubs and research facilities in the Columbus suburban area. Known as the Connected Vehicles/Smart Mobility Project, it is funded through a \$5.9 million grant from the U.S. Department of Transportation and in coordination with a \$140 million Smart Cities Challenge grant awarded to Columbus, Ohio, for deployment of smart technologies. This grant funding is indicative of recent federal and state government investments to encourage smart city demonstration projects nationwide.¹

¹ Sheet on Connected Vehicles / Smart Mobility Project, City of Dublin, Ohio, Alliance for Innovation Conference, October 2016.

Mobile Applications

Cell phones and smartphones, tablets and laptops have all created numerous avenues for informing and communicating with customers, remote field operations, and vendors. These mobile technology platforms enable traffic and weather alerts, inspection reports, real-time audits, and utility monitoring from the field, thereby improving response times, inventory control, and equipment maintenance. Customer services are enhanced through online information systems and account management or improved functionality of such municipal systems as locator apps for finding vacant parking spaces, rental housing, and general directional assistance to community facilities.

Modeling

Modeling software helps us understand the physical forces at play in the environment and what the likely results of those forces may be. Most of us are familiar with weather models on television, but modeling software is used for many other purposes, such as using data to predict where crimes are most likely to occur or how new development, signal improvements, or transit routing might affect traffic patterns. Coastal modeling maps out the physical forces at play on a coastline to help determine what engineering solutions might help offset erosion. Weather models help anticipate where damage is most likely to occur during severe storms.

A New Space Age

Expanded military and private space exploration has always fueled innovation and distribution of new technologies for public use. It also has the potential to increase mineral and energy resources, which will advance the prospects of enhanced urban environments on earth.

Photographic Recognition and Remote Sensing

Use of photographic recognition technology, often using biomarkers and remote sensing, has produced opportunities to enhance security and policing intelligence and monitoring by identifying participants entering facilities, estimating crowds and carrying capacities, and performing inventories of species and resources. Refinements in high-definition, high-altitude remote sensing via satellite and miniaturization of cameras, along with the extensive accompanying metadata associated with photos, are improving the effectiveness of these tools. The improvements allow analytical platforms to assist in identifying an individual's facial features or recognizing license plates or measuring nutrients and moisture in micro regions in agricultural fields.

Pocket Supercomputers for Everyone

Increasing power in smartphones and computers will create opportunities for networked community intelligence and problem solving, remote learning, and civic participation in a manner never envisioned before.

Self-Driving, Autonomous Vehicles

These “driverless” vehicles pose major possibilities for reduction in vehicular deaths, traffic congestion, and parking scarcity, plus opportunities for fuel savings and productivity increases on fixed-route delivery of services.

Smart Building and Construction

Technology is enabling a variety of smart construction materials and architectural designs that enable greater control of energy and water utilization and conservation. These materials have greater temperature resistance and energy capture, such as solar roofing tiles, cooling systems, and gradients of light filtration that adapt to seasonal energy requirements. Adaptive architectural designs, SCADA (supervisory control and data acquisition) monitoring, and efficient energy management systems and controls often remotely can monitor and control building and lighting requirements based on peak use. They can also supplement traditional sources as needed with alternative energy sources such as wind, geothermal, biofuels, and tidal forces.

Smart Grids

One of the major developments enabling smart communities is the technical ability to integrate formerly separate technologies into integrated systems. These integrated systems use and transfer data and information from remote sensors to record, monitor, and activate system-wide operational changes in connected grids, such as traffic signalization and electric, sewer, and water production and distribution systems. This maximizes the infrastructure's potential carrying capacity, resource conservation, and efficiencies.

Social Media and Crowdsourcing

Social media and crowdsourcing provide a means for citizens to become engaged in situational analysis. Through posts on social media sites and by submitting data to a centralized collection point, citizens can provide nearly real-time data on what's happening in effected neighborhoods. For instance, governments can invite citizens to take photos of potholes and other safety hazards in the community and send the photos to the local government. Following the BP oil spill in 2010, volunteers used crowdsourcing to document where

clean-up efforts were most needed. More than just a virtual neighborhood watch, crowdsourcing can also be used to spot trends and analyze data on **public health** or flood risk. Crowdsourcing can inspire collaboration on engineering or IT challenges, and can help agencies arrive at solutions much more quickly than if they needed to rely solely on internal resources.

Solar and Wind Technologies and Fuel Cells

Solar, wind, and water are all sources of clean energy with less pollution than fossil fuel, and technology advancements will provide lower costs and improved efficiency in such uses as renewable fuel cells and electric vehicles. Innovation hubs and research are focusing on clean energy for job creation and economic development.

Virtual and Augmented Reality

Virtual reality (VR) and augmented reality (AR) can enhance user experiences in most communication and computer platforms. They will continue to enhance participation in remote meetings and simultaneous venues; medical and psychological treatments; and community learning, promotion, and recreation programs, just as gaming technology is doing. 3-D holograms are replacing cadavers in medical and tactical military training, and allowing historical figures to appear animated.

Appendix B: Smart Cities Resources

Articles

“**The Rise of the Smart City**,” by Michael Totty, in *The Wall Street Journal*, is an article about the worldwide rise of smart cities and innovative uses of technology: <https://www.wsj.com/articles/the-rise-of-the-smart-city-1492395120>

“**The Rise and Fall and Eventual Rise Again of the ‘Smart City’**,” in *The Atlantic* CITYLAB, January 13, 2014, is a conversation with *Smart Cities* author Anthony Townsend: <https://www.citylab.com/life/2014/01/rise-and-fall-and-eventual-rise-again-smart-city/8081/>

In “**Tech-Savvy Cities May Be ‘Smart,’ But Are They Wise?**” in NPR’s Morning Edition/All Tech Considered department, NPR’s David Greene interviewed *Smart Cities* author Anthony Townsend about the causes, benefits, and potential dangers of the smart city boom. <http://www.npr.org/sections/alltechconsidered/2013/07/18/200792512/DG-TOWNSEND>

Forbes.com features contributor Peter High’s “**The Top Five Smart Cities in the World**,” as identified by author Steffen Sorrell for Juniper Research. Sorrell identified five essential components of a smart city: technologies, buildings, utilities, transportation and road structure, and the smart city itself. <https://www.forbes.com/sites/peterhigh/2015/03/09/the-top-five-smart-cities-in-the-world/#2d3f60ba67ee>

General Resources

- *The Atlantic’s* Citylab is a good general resource about smart cities: <https://www.citylab.com/life/>
- *Wired* magazine’s website often features smart technology: <https://www.wired.com/>
- *Popular Science* is another resource for regular reading on smart technologies: <http://www.popsci.com/>
- <http://www.popularmechanics.com/technology/> is an excellent source for reading about smart technologies and a practical approach to construction of smart systems.
- <https://www.scientificamerican.com/> is a source for new developments in science affecting smart cities and sustainability.
- The Massachusetts Institute of Technology’s *Technology Review* <https://www.technologyreview.com/> is one of the better reads on smart technology. This *Technology Review* article, “10 Breakthrough Technologies 2017,” is a quick read on smart technology trends: <https://www.technologyreview.com/lists/technologies/2017/>
- GT—Government Technology: State & Local Government News Articles <http://www.govtech.com/3-Smart-City-Trends-to-Expect-in-2016.html> is another reading source focused on government and technology.
- <https://innotechtoday.com> brings together an eclectic mix of articles on innovation and technology.
- The Smart Cities Council’s [website](http://www.smartcitiescouncil.com) (smartcitiescouncil.com) offers numerous useful resources, including SCC’s **Smart Cities Readiness Guide** (readinessguide.smartcitiescouncil.com) and **Smart Cities Finance Guide** (na.smartcitiescouncil.com/resources/smart-cities[-financing-guide]).

Survey Findings and Reports

2016 ICMA Smart Cities Survey Summary Report and Snapshot: In 2016, ICMA conducted a survey in partnership with the Smart Cities Council to learn more about the motivators, barriers, priorities, and activities of U.S. local governments related to smart city technologies. <https://icma.org/documents/icma-survey-research-2016-smart-cities-survey-summary-report>

Smart Cities of the Future: Presentation by Elizabeth Kellar (senior fellow at the Center for State and Local Government Excellence and public policy director for ICMA) at the 2016 Global City Teams Challenge Tech Jam. <https://icma.org/documents/smart-cities-future>

Trends in Smart City Development is a report from the National League of Cities Center for City Solutions and Applied Research (copyright © NLC 2016). The report features case studies about how five cities are using different approaches to implement smart city projects. <http://nlc.org/search-0?q=Trends%2520in%2520Smart%2520City%2520Development.pdf>

Smart Cities and Communities Federal Strategic Plan is a report developed by the Smart Cities and Communities Task Force, which is a body under the Networking and Information Technology Research and Development (NITRD) Cyber-Physical Systems (CPS) Interagency Working Group. The draft plan for public comment was released in January 2017 and “offers a high-level framework to guide and coordinate smart city/community-related Federal initiatives, with an emphasis on local government and stakeholder engagement.” https://www.nitrd.gov/drafts/SCC_StrategicPlan_Draft.pdf

Topics

Cybersecurity

ICMA, in partnership with the University of Maryland Baltimore County, surveyed CIOs about cybersecurity practices and related issues. The results of the **Cybersecurity 2016 Survey** reveal the kinds of barriers local governments face as well as the support they receive to implement cybersecurity programs. <https://icma.org/documents/icma-survey-research-cybersecurity-2016-survey>

The March 2017 article “**Cybersecurity: Assistance for Local Governments?**” describes newly introduced legislation that would provide funding and technical assistance to help local governments defend against cyber crime. <https://icma.org/articles/cybersecurity-assistance-local-governments>

Local Government Cyber Security: Getting Started—A Non-Technical Guide is a publication of the U.S. Department of Homeland Security National Cyber Security Division in collaboration with the Multi-State Information Sharing and Analysis Center. It describes the objectives of local government cybersecurity and offers a “cybersecurity tasks” quick reference checklist as well as a list of 10 cybersecurity action items. https://icma.org/sites/default/files/307666_Local%20Government%20Guide%20to%20Cybersecurity.pdf

Energy

Energy Efficient Infrastructure Development is an ICMA white paper that includes a case study analysis of leading practices on three types of energy efficient infrastructure, microgrids, smart meters, and building retrofits. The paper was prepared by Michael Titzer, American University, and was published in April 2015. <https://icma.org/node/67522>

Smart Green Cities reports on a survey of local government leaders and industry stakeholders in North America. The survey, sent to city leaders and energy service providers, explored the benefits and problems inherent in city utility partnerships for transforming communities into smarter and greener cities. The Smart Green Cities survey was conducted by DNV GL. (DNV GL is a consulting, testing, and certification company for the global energy sector, located in Oslo, Norway.) The report was published in January 2016, and discusses opportunities and challenges for cities and utilities to work together to successfully implement smart green city solutions. <https://www.dnvgl.com/energy/publications/download/smart-cities-survey.html>

Solar Outreach El Paso, Texas Case Study: Case study showcasing El Paso’s solar photovoltaic programs and the city management’s efforts to make El Paso the most livable city in the U.S. by focusing on sustainability and smart growth. <https://icma.org/node/65219>

Infrastructure

Orchestrating Infrastructure for Sustainable Smart Cities: International Electrotechnical Commission’s white paper on how a wide collaboration between many stakeholders can move cities to greater smartness. IEC is a nonprofit organization that prepares and publishes international standards for all electrical, electronic, and related technologies. <http://www.iec.ch/whitepaper/smartcities/>

Access and Inclusion in the Digital Age: A Resource Guide for Local Governments is designed to support U.S. communities of all sizes and geographies in advancing their goals for high-speed Internet access and digital inclusion. This guide is a collaborative effort of the National Telecommunications and Information Administration, the National Research Network, and several U.S. cities. http://nationalresourcenetwork.org/en/Document/306284/Access_and_Inclusion_in_the_Digital_Age_A_Resource_Guide_for_Local_Governments

Internet of Things (IoT)

“**Driving the Future of Smart Cities with IoT**,” by Kurt Steward in *GCN: Government Computer News for Public Sector IT*, is an article on the impact of the Internet and remote sensors as a source driving smart cities possibilities. <https://gcn.com/articles/2017/06/02/iot-smart-cities.aspx>

IoT 2020, Smart and Secure IoT Platform: The International Electrotechnical Commission's **IoT 2020** white paper provides an overview of today's IoT, including its limitations and deficiencies in the area of security, interoperability, and scalability. It includes case studies and discusses next-generation platform-level technologies in the field of connectivity, processing, and security. <http://www.iec.ch/whitepaper/iotplatform/?ref=extfooter>

Partnerships

Using Partnerships to Power a Smart City: A Toolkit for Local Communities (November 2016), by Broadband USA, U.S. Department of Commerce, and National Telecommunications and Information Administration, describes why partnerships are the foundation of smart cities and how to develop a partnership strategy. https://www2.ntia.doc.gov/files/smartcities-toolkit_111516_v2.pdf

Power of Data

What Counts: Harnessing Data for America's Communities:

This e-book is designed to be useful to practitioners, policymakers, funders, and the data intermediaries and other technical experts who help transform all types of data into useful information. Some of the essays address high-level systems-change work while others offer practical, "how to" approaches. The book is a joint project of the Federal Reserve Bank of San Francisco and the Urban Institute and was published in 2014. One of the articles in the book was written by Cory Fleming and Randall Reid from ICMA: "Enabling and Driving Performance Management in Local Government." www.whatcountsforamerica.org/wp-content/uploads/2014/12/WhatCounts.pdf

Big Data and Planning (PAS 585): American Planning Association's 2016 Planning Advisory Service (PAS) Report. The report is a practical guide to channeling the power of big data. Authors Kevin C. Desouza and Kendra L. Smith, both from Arizona State University, analyze how planners around the world are turning big data into real answers for smart cities. <https://www.planning.org/publications/report/9116397/>

Open Data, Digitalisation and How to Create Smart Cities of the Future: The Guardian's article on open data, digitalization, public engagement, and data security was released on February 15, 2017. <https://www.theguardian.com/odine-partner-zone/2017/feb/15/data-digitalisation-smart-city-future>

Public Engagement

10 Lessons in More Engaging Citizen Engagement: Bring the Town Hall Online In Vancouver, British Columbia, Canada, the mayor hosts Twitter town halls on topics such as citizen engagement, homelessness, and housing affordability. At the first such Twitter town hall, Mayor Robertson—using the hashtag #askgregor—hosted a high-profile virtual town hall meeting at the offices of Hootsuite, a Vancouver-based social media company. The **website** for the city also includes engagement opportunities. <https://www.planetizen.com/node/67656>

Using GIS to Enhance Public Engagement: The Federal Emergency Management Agency's (FEMA) initiative to update the flood plain maps for communities participating in the National Flood Insurance Program raised considerable public concern in Auburn, Alabama. Auburn officials considered public engagement to be a key element in the successful completion of this project. In addition to the traditional community meetings and the paper-based notifications, an interactive, web-based mapping solution was created to allow the public to browse both the current and proposed flood plain maps and to see the proposed changes in real time. <https://icma.org/articles/using-gis-enhance-public-engagement-auburn-al>

Public Safety

"Video Quality in Public Safety (VQiPS): Policy Considerations for the Use of Video in Public Safety" (U.S. Department of Homeland Security, June 2016) discusses public safety issues as well as the importance of governance. https://www.dhs.gov/sites/default/files/publications/Policy%20Considerations%20for%20the%20Use%20of%20Video%20in%20Public%20Safety_Final_v4.pdf

Transportation

How Cities Are Integrating Rideshare and Public Transportation: An article on how transit agencies in the U.S. try to support mobility in their cities and suburbs by using smart transportation solutions. The article is posted on Data-Smart City Solutions, a platform hosted by Harvard Kennedy School. <http://datasmart.ash.harvard.edu/news/article/how-cities-are-integrating-rideshare-and-public-transportation-978>

Other Examples

Creating and Nurturing a Smart City Ecosystem:

Presentation made at the 2015 ICMA Annual Conference on smart city activities in Charlotte, North Carolina. <https://icma.org/node/67970>

Fort Lauderdale, Florida: Developing a Resilient, Smart

City: ICMA-Esri Smart Communities Case Study explores how this city utilized GIS (geographical information system) technology to increase its community resiliency. <https://icma.org/node/66033>

How Smart City Barcelona Brought the Internet of Things

to Life: Barcelona deployed responsive technologies across urban systems including public transit, parking, street lighting, and waste management. Barcelona has been portrayed as a leading example for smart city activities. <http://datasmart.ash.harvard.edu/news/article/how-smart-city-barcelona-brought-the-internet-of-things-to-life-789>

Growing Greater Geraldton: The city of Geraldton, Australia, has integrated a smart city/region approach, and this economic growth plan includes examples of smart city activities that will be implemented—such as smart labs, a project encouraging businesses to pilot their products/services in Greater Geraldton to demonstrate technologies to proof-of-concept stage.

The Smart City Movement: ICMA's *PM (Public Management)* magazine article published in the December 2016 issue features examples of smart city technologies that have been implemented in various communities in the U.S. <https://icma.org/node/41315>

The Mecklenburg Livable Communities Plan: More than 2,000 individuals in Mecklenburg County, North Carolina, came together to define the county's vision between 2013 and 2014. Currently, local governments, nonprofits, and businesses are partnering to transform that vision into action. <http://www.livablemeck.com/>

Websites of ICMA Partners Active in Smart Cities Work

Visit <https://members.icma.org/eweb/DynamicPage.aspx?WebCode=strategicpartners&Site=icmares> for an ICMA directory of these partners with active links to their websites:

BoardDocs, Buxton, Ch2M, Corporater, eCivis, Esri, IBTS, Microsoft, NeoGov, OnBase, Opengov, SAS, Siemens, Smart Cities Council, Socrata, and Verizon

Contributors



Chris Fennell, Director of Marketing and Business Development at IBTS, has more than 30 years of experience in domestic and international design, construction, operations management, and research in the built environment.



Samuel Fleishman, Senior Research Analyst at IBTS, has almost 20 years of wide-ranging consulting experience with a focus on green building and B2B market research.



Cory Fleming is Senior Technical Specialist/ Program Director, ICMA. She directs ICMA's 311/CRM Consulting Services, and from 2006-2011 she was the project director for the ICMA National Study of 311 and Customer Service Technology (icma.org/31). Fleming has written extensively about the use of data for improved local government service delivery and performance measurement.



Patrick Howell, IBTS Program Manager, has over twelve years of experience in the public, private, and nonprofit sectors collaborating with domestic and international communities to improve public service delivery and generate sustainable revenue sources.



Karen Johnson is Market Research Manager at IBTS. She has over 20 years of experience in market research analysis and strategy consulting for both the public and private sectors, with a focus on innovation in the built environment.



Randall Reid is ICMA Director of Performance Initiatives. He has over 40 years of experience as a city and county manager and represents ICMA on the board of directors of the Alliance for Innovation.



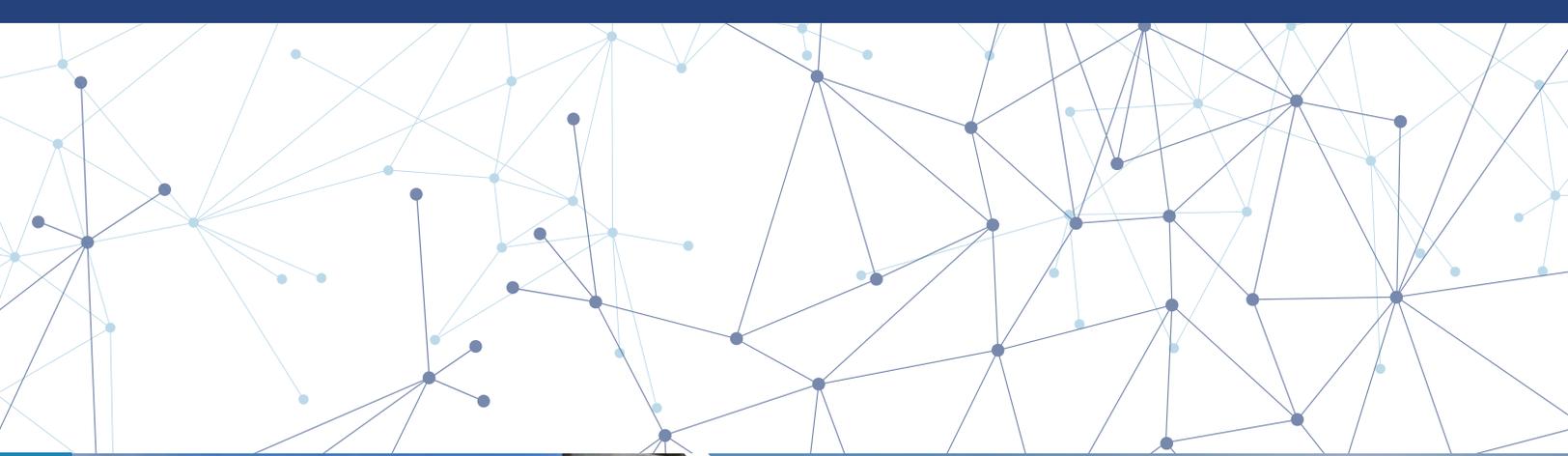
Avery Share, Research Analyst at IBTS, focuses on qualitative research, interviews, case studies, and website content development.



Brian Watson is Transition Coordinator in IBTS's Local Government Services Division. He works with small-to-medium-size cities to ensure customer satisfaction with IBTS services and to provide assistance among on-site teams, the headquarters office, and city officials.



Gerald Young is Senior Research Associate, ICMA. He has worked for ICMA since 1998 on performance management, best practices, and research and policy. Prior to joining the staff, Young worked in local government for the cities of Loma Linda and Chula Vista, California.



ICMA

