Joseph N. Pelton
Indu B. Singh

Smart Cities of Today and Tomorrow

*Better Technology,
Infrastructure and Security*

Springer

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Preface

In 2008, both authors were heavily involved in urban planning. In one instance, Joe Pelton was chairing the IT Advisory Commission for Arlington County, Virginia, and also preparing a proposal nominating Arlington County for the Intelligent Community Award as annually presented by the Intelligent Community Forum. In the other instance, Indu Singh was then involved in advising communities on three continents about how to design smart communities responsive to citizen needs and also include the most appropriate new technology. We had also worked together over the years in closely related fields. That year, we had also decided to put on a conference on emergency communications at George Washington University, where one of us then headed a telecommunications and computer program. During our collaboration, we decided to write a book entitled *Future Cities* that was published in 2009. We followed that initiative by writing another book together entitled *Safe Cities: Living Free in a Dangerous World.* This was published by the Emerald Planet in 2013. Then, we next worked together on *Digital Defense: A Primer in Cyber Security* that we published in 2015.

This lasting and effective partnership has now continued, and this is our latest book. It explores the ins and outs of planning, designing, implementing, and operating an intelligent community. This book, *Smart Cities of Today and Tomorrow,* combines the experience and research represented by our two different yet interlinked lifetimes of practical consulting and academic experience. We have been involved in the planning and engineering of telecommunication and IT systems, of security networks, of urban infrastructure, and of city planning, and this book reflects the knowledge and research findings we have accumulated through this process. We believe in more effective and brighter urban futures and hope this book might help light the way.

Certainly one of the keys to good smart city planning is to engage the citizenry in effective and responsive ways to make their cities a better place to live. We hope what follows is a useful guide with regard to key issues and offers useful advice about better ways to involve citizenry in the planning process. Further, we hope it illuminates some smarter ways to make key urban investment and planning decisions and create better longer-term goals and a clear vision of what you want your city to become.

There are many things to consider in trying to plan and create a smart city, but if we were to try to boil down our top advice to a single sentence, it would be along these lines: suburban sprawl is bad, and thus urban density is good, but when a city becomes ultra-dense, this intense overconcentration of people, transport systems, and infrastructure becomes bad again. We believe scale and what we call meta-city planning concepts are keys to a smart city as much as the use of smart technology.

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Fairfax, VA, USA   Indu B. Singh

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About the Authors

Joseph N. Pelton is a widely published award-winning author with some 50 books written, coauthored, edited, or coedited. His *Global Talk* won the Eugene Emme Literature Award and was nominated for a Pulitzer Prize. He is the coauthor with Dr. Singh of the book *Future Cities* published by the Intelligent Communities Forum in 2009 and *The Safe City: Living Free in a Dangerous World* in 2013. Dr. Pelton is currently the principal of Pelton Consulting International. He is on the executive board of the International Association for the Advancement of Space Safety and chair of its International Academic Advisory Committee as well as the former president of the International Space Safety Foundation. He is the former dean of the International Space University (ISU) of Strasburg, France. He also served as chairman of the ISU's Board of Trustees. He is the director emeritus of the Space and Advanced Communications Research Institute (SACRI) at George Washington University. Dr. Pelton was the director of the Interdisciplinary Telecommunications Program at the University of Colorado from 1988 to 1997. At the time, it was the largest such graduate program in the United States. During his academic career, Professor Pelton taught at American University, the University of Colorado Boulder, and George Washington University and served as VP of academic affairs at the ISU. His undergraduate degree in physics is from the University of Tulsa, his master's is from New York University, and his PhD is from Georgetown University in political science and international relations. He previously held various executive positions at Intelsat and Comsat, including serving as

director of Project SHARE and director of strategic policy for Intelsat. Intelsat's Project SHARE gave birth to the Chinese National TV University and many other tele-health and tele-education programs around the world. Dr. Pelton was the founder of the Arthur C. Clarke Foundation and served for many years as its executive director. He was also the founding president of the Society of Satellite Professionals (SSPI) and has been recognized in the SSPI Hall of Fame. He has served on the Board of the International Institute of Communications. He has been active with the World Future Society and also frequently speaks and writes as a futurist. Dr. Pelton is a member of the International Academy of Astronautics, an associate fellow of the American Institute of Aeronautics and Astronautics (AIAA), and a fellow of the International Association for the Advancement of Space Safety (IAASS). He is the winner of the IAASS da Vinci Award and the 2017 Guardian Award of the Life Boat Foundation, which has been previously won by Bill Gates, Elon Musk, Warren Buffet, and Prince Charles. He has served as president of the Arlington County Civic Federation, as a member of its Long-Range County Improvement Commission that initiated "smart growth" in Arlington, and as also the immediate past chair of the IT Advisory Commission for Arlington County that plays a key role in protecting the safety and resilience of the county's telecommunications and IT networks and helps to initiate the ConnectArlington fiber optic network. Dr. Pelton resides in Arlington County, Virginia.

Indu B. Singh, Ph.D. is president and CEO of Planet Defense LLC. He is an internationally recognized consultant for smart cities and cybersecurity. Most recently, he served as senior director in the Intelligence Services Division of General Dynamic Information Technology (GDIT). Prior to this, Dr. Singh was vice president and head of Washington, DC, operations for Los Alamos Technical Associates (LATA). Dr. Singh also served as executive director of LATA's Global Institute for Security and Training (GIST), which he founded in 2012. Prior to joining LATA, Dr. Singh served as director and managing partner in Federal Government Services at Deloitte Consulting LLC, where he managed systems engineering and security practice. At BearingPoint, Inc. (formerly KPMG Consulting), Dr. Singh was a managing director

and partner and operated his global practice in systems engineering, security, and IT transformation. Dr. Singh is considered a pioneer in the designing and implementing of smart cities and safe cities around the world. He has led projects to design, build, and completely implement new cities and urban security and IT systems in the United States, Europe, Asia, and the Middle East. Dr. Singh has led workshops and seminars in a number of areas such as urban security systems, cyber defense for smart cities, designing and building of smart cities, as well advance training in cybersecurity and the smart city. He has significant business and technology management experience with a proven P&L track record. Dr. Singh founded three midsize high-tech companies and served as president and CEO. In 1998, he became a founding shareholder of an Internet company and took the company public within 2 years. His business and consulting experience includes management and technical consulting, smart city, cyber and network security, telecommunications and IT, managing technology companies, domestic and international business development, mergers and acquisitions, turnaround, investment capital, and strategic partnership in domestic and international environment. Dr. Singh has executed engineering, security, and IT businesses in 49 countries and has traveled to 81 countries. Dr. Singh's management consulting approach combines technical, organizational, and strategic management principles to create an effective and productive organization. In 2009, he joined with Dr. Pelton in writing *Future Cities: Designing and Building Smart Cities* as a project for the Intelligent Community Forum headquartered in New York City. Dr. Singh also teamed with Dr. Pelton to write *The Safe City: Living Free in a Dangerous World* and *Digital Defense: A Cybersecurity Primer,* which were published in 2013 and 2015, respectively. Dr. Singh has published five other books on telecommunications, IT systems, and security and was founding editor in chief of *Telematics and Informatics*, a global technology journal published by Elsevier. Prior to joining the business world, Dr. Singh served as a professor at Rutgers University. He also served as adjunct professor at the Kogod School of Business at American University and the School of Business at George Washington University. Dr. Singh resides in McLean, Virginia, USA, with his family.

Chapter 1
The Coming Age of the Smart City

> *"Our prime obligation to ourselves is to make the unknown known. We are on a journey to keep an appointment with whatever we are."*
>
> —*Gene Roddenberry*

The early 21st century is the time of disruptive technologies. Uber, a software company, is now the world's largest taxi service. Airbnb, another software company, is now the world's largest hotel company. Amazon.com and Ali Baba, both essentially dot.com companies, are the largest retailers. It thus should not come as a huge surprise that broadband, AI and IT systems are now poised to disrupt conventional ideas as to how to plan for, operate, invest in, and even re-invent the concept of what is called a 'smart city.' These powerful new digital technologies are strangely suited to being economically, socially and politically disruptive to every aspect of society—including urban life and city planning in contemporary times.

This book is a rough guide to what is meant by a smart city—both today and tomorrow. Its main mission is to make a plea that urban planners do not fall into the trap of thinking that the way forward is to throw technology at ever demanding problems that a city faces. No, we argue that the way forward to livable and effective smart cities involves 'smart planning' and judicious use of technology. This book is about the opportunities that a smart city can provide and the threats that it must overcome.

This is not a book about technology per se but having the wisdom and foresight in planning for better and more sustainable towns and cities. It is about the tremendous potential that can be unlocked and significant threats that can be overcome in this new digital age. This is a time that is filled with disruptive systems—economic, social, political and technological. Yet it is also replete with amazing new opportunities.

Most people—if they are honest—find things that are hard to understand and verging on 'nerdiness' quite boring. Just try to strike up a conversation at a cocktail party about differential equations, a new type of electronic ion propulsion system

for satellite stabilization, or the latest breakthrough in turbo-coding for efficient digital networking. Trust us, it doesn't work out well.

But the good news is that this particular smart city book charts a different path forward. We hope we have found the narrow and treacherous course that steers between being informative on one hand and dullsville on the other. If you wish to read about a viable way forward to achieve a better future for cities and how life might be lived in quite different ways in coming decades, we hope this is it. The trick is to explain these new trends and patterns of urban living without having to wade through reams of technobabble and intricate formulas. We try to sort through the threats that smart cities face from cybersecurity to technological overkill.

The *21st Century Smart Cities* seeks to be a good read. It is not a thrilling novel filled with sex, gore and intrigue, but it truly attempts to be engaging, informative, and entertaining. Fun facts range from what exactly are bitcoin and crypto-currencies and how block chain technology will change our lives. It explores the how and why of the Internet of Things (IoTs) and how it will soon evolve into the Internet of Everything (IoE). You will find out how living in a smart city will very likely transform your life by altering your sense of security, key educational systems, health care, your job, and your family life. Other than that, everything will remain pretty much the same.

Advances in smart city design and technologies will underscore how cybersecurity will become even more important to your life and your sense of security. This book takes you through ever key aspect of the evolving smart city and then ends by giving you our top twelve tips on how to live a more rewarding and secure life in this unfolding world of tomorrow.

Interesting, informative, exciting, and perhaps occasionally even amusing—these were the watchwords that we adopted as our mission statement for this book. If we are lucky we might even find a few ways to make it fun and exciting. We might be pushing it to say that it is fun, but perhaps sometimes there can be a chuckle or two.

What we are shooting for is a book that is filled with some new and intriguing facts about life, jobs, and existence in a future urban world. We pose a number of challenges for civic planners to consider and puzzle over. We even explore a few instances where smart city aspirations have gone awry and add in a dollop of political intrigue that comes with 'trolling' and cyberattacks on cities of the future and democratic societies. We thus make a sincere effort to explore some of the big challenges concerning the future of life on Planet Earth. By 2050 the world will be more than 80% urban, dramatically up from it being 53% urban today. This surge in urbanism and the rise of megacities represents perhaps the most important, and perhaps most dangerous, global trend in the world today.

We will explore the world of megacities, which are larger in population than many of the countries combined that exist in today's world. We will see how more and more megacities will become much larger than is optimum for efficient governance. There is a point where super density exceeds an increasing economy of scale and efficiency. Several times you will hear in this book that suburban sprawl is bad, urban density is good, but super density is bad again. It's bad for quality of life. It's bad for security and responsiveness to natural and human-generated disasters. It's bad for civic participation in building a better tomorrow.

This is only one of the oddities of this urban world of tomorrow. Our mission is to explore how these giant cities will adapt to the needs of their huge populations and their giant budgetary and service needs. Our top focus will thus be on these enormous cities and the need to create new, smart meta-cities that will surround these 21st century "city states." How can we help chart a future in which new meta city become more efficient, more secure, more livable, and more economically and environmentally viable? These are central to our discussions that follow.

It is vital to consider the experience drawn from emerging smart cities around the world. Many of these lessons learned are the essence of this book. Also key are the highly informative databases of best practices collected by entities such as the Intelligent Community Forum in New York City. This key organization has now collected key data from more than 300 smart cities from around the world. These and other narratives will enrich the fabric of our tale.

Let us start by saying what our idea of a smart city is. A smart city is not a thing, nor a technology, but a process that combines various elements together in a creative way. The seven elements key to creating a smart city are summarized in Fig. 1.1, describing the vital aspects of a smart city.

A smart meta-city system can be created within an existing and well-established city, or as one or more new towns at the edge of a large city. Alternatively, efforts can be undertaken to transform a megacity into a smart city, but this is the largest challenge of all. We believe that these satellite meta-cities, developed primarily on the edges of today's gigantic megacities of more than ten million people, will be vital to enhancing the livability and security of the megacities themselves as they too are transformed. Telework and 'smart' transportation systems will be key aspects of these transformations.

We will show how various communities around the world are today leveraging broadband communications systems, cybersecurity concepts and smart city planning to make 21st century urban living better. It might be to relieve the snarl of traffic

• **Fulfilling Citizens' Needs** – Education, Health Care, Housing, Infrastructure Needs, Digital Equality
• **Sustainability/Circular Economy**– Managing environmental change, urbanization and coping with population growth and climate change.
• **Jobs & Competitiveness** – Improving the city's competitiveness, economic growth, creating jobs, and retraining programs.
• **'Smart Planning' and Citizen Support** , 'Intelligent' data analysis, broad community involvement, retaining youth,
• **Infrastructure & Resources** – Delivering enhanced key services to citizens and businesses-- reliably & cost-effectively.
Technology & AI – Use of smart technology to support community needs
Security -- Protection against cyber-attack& natural disasters, protected infrastructure, and first responder needs.
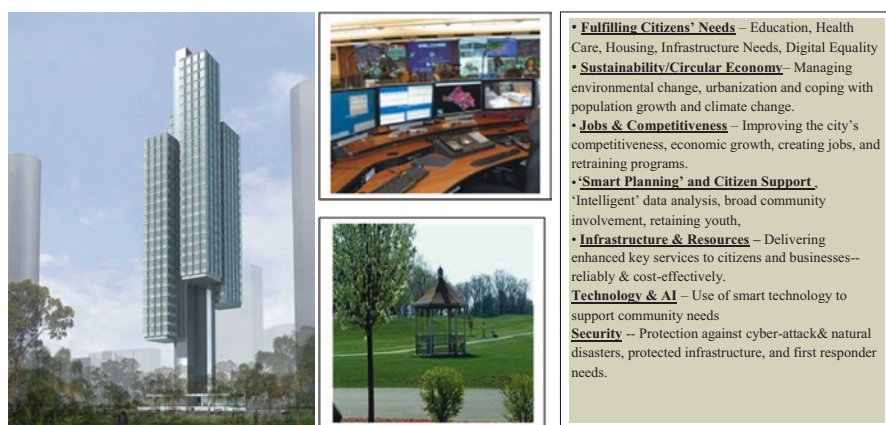
Fig. 1.1 Seven key elements in planning for and creating a smart city. (Source: Presentation by authors to Arlington County on March 14, 2018)

jams, to reduce crime, to ease the scourge of smog and greenhouse gases, or to offer
better employment and security to its citizenry. This is a book about real problems
in today's cities, but also about inventing new tools and better solutions for the cities
of tomorrow.

In essence, this book about smart cities is thus really about what humans want to
do with their lives when global society reaches the peak of many millennia of
development. We explore some of the issues that arise when we reach a state of global
human achievement that Peter Diamandis has called the "Age of Abundance," or
which Ray Kurzweil called "the Singularity." Will the cities of tomorrow be "smart"
or "dumb"? Will they be livable or quite overcrowded? Will they be functional,
enjoyable, or perhaps both?

We also have to be honest. This book about smart cities does, on occasion, talk
about technology and urban problems. We explore what life will be like when the
world is over 80% urban and automation has redefined work and 90% of
communications in the world will not be between people but between machines in
the world of the Internet of Everything. Smart does not automatically mean better,
more livable, or more secure. We have to work—and work hard—to make our cities
places where we would want to live and raise our families. Technology is not a
panacea. Technology provides improvement in the quality of life only with smart
planning and clear thinking.

There are several things we can say for sure. This future urban world will be rife
with significant change, as will be seen in the following:

- Social, economic, and cultural changes will occur rapidly.
- Human-machine interfaces will be critical to security and progress.
- Security will be a challenge—particularly cybersecurity.
- Lifelong education and retraining will become a way of life and health care an
  enormous challenge.
- Multiple job changes and careers will be commonplace as we cope with
  super-automation.
- Significant societal challenges will include longer life, challenges to individual
  privacy and perhaps democratic freedom.
- Technological and cyber challenges will likely require coping with "future
  compression," threats from cyber-criminals and even attacks launched by
  techno-terrorists and cyber-attacks on weapons of mass destruction.
- Concerns with increase with mega-problems such as climate change challenges,
  over-dependence on automated systems and artificial intelligence, changing
  global demographics, information overload, the digital divide and mass migration
  and immigration.

Key technological changes that we can depend on seeing in smart cities will
likely include many of the elements depicted in Fig. 1.2.

We explore issues such as what will our lives be like in the future? There are
fundamental questions such as how we adapt to a future where cities are no longer
a place just to live but a living—almost breathing—environment. How do we best
interact with an animated city that is not only "smart" but sometimes intrusive and

Smart City Technologies

•Artificial Intelligence & Super Automation
• M2M Communications & Pervasive Broadband Mobile
• 'Smart' Energy Grids
• Talking & Serviceable 'Bots'
• Driverless Transport
•Internet of Everything
• Advanced Cybersecurity
• Human-Machine Interface
• Telework, Tele-education & Tele-Health Services
•Telecity Architecture & Virtual Companies
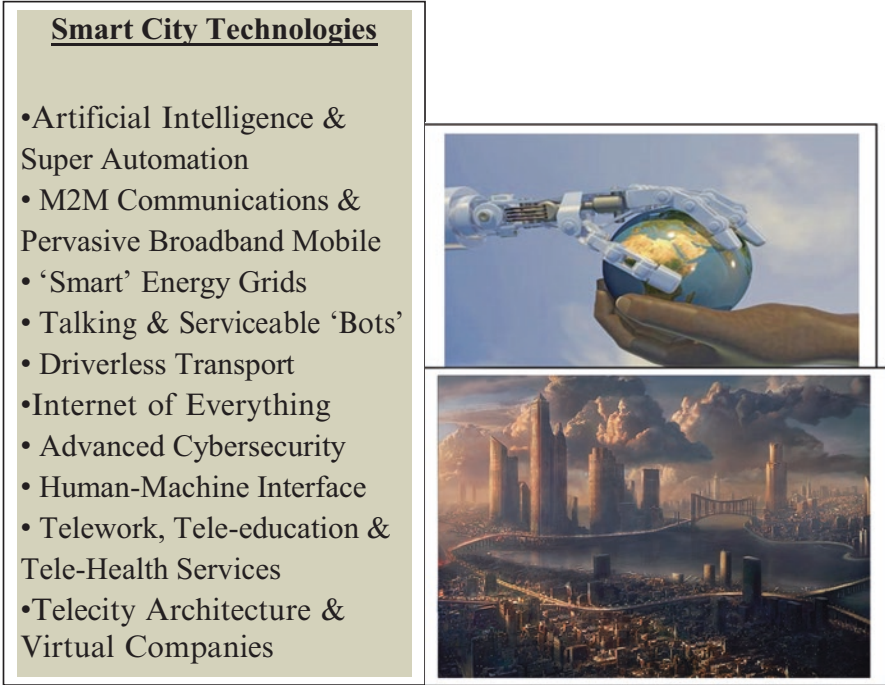
Fig. 1.2 Key smart city technologies. (Source: Presentation by authors to Arlington County on March 14, 2018)

even overprotective of its citizenry. If we are not careful, living in a smart city might curtail our privacy and potentially threaten democratic core values such as freedom, liberty and the pursuit of happiness.

This is because smart cities involve a little bit of everything, from social media and loss of privacy, to hackers and techno-terrorist attacks, from the latest developments in cloud computing and 'smart' homes and buildings and cars that can talk to you, to ways to save your life and lower your energy bills. In this new world, the divide between rural and urban populations, culture and politics that is already wide could become even wider with dangerous implications and results. So, hang on as we explore the opportunities and the challenges of the smart city.

Further Defining a Smart City

Many people have their own definition of a smart city and what it means to a populace. To our minds it is not defined by and through technology—although smart technology is still quite crucial. What makes a smart city is re-envisioning its design and functioning so that it can produce a better life and higher quality and

standard of living for its citizenry. This is to say that a smart city provides a community with improved health care and educational opportunity, higher security against natural and human-made disaster, social and political stability and freedom, economic prosperity and thriving businesses, and better housing, transportation, communications, networking, energy and all its other critical utilities.

The people in a true smart city have the opportunity for a safer, more well-rounded and prosperous life by being better equipped to enjoy the opportunity that a smart city provides to individuals, neighborhoods and the community at large. Figure 1.1 outlined the key elements of a smart city. These include: (i) fulfilling citizens' and business needs; (ii) creating environmental sustainability and a circular economy rather than a disposal economy; (iii) offering more jobs and competitiveness; (iv) getting citizen support for smart city planning; (v) improving infrastructure and resources; (vi) providing better technology and artificial intelligence; and (vii) providing better security. These seven concepts or goals are relatively clear, but executing them in an effective and systematic way remains hard. Indeed, coping with rapid technological change may be the most difficult challenge that society and cities will have to face during the span of the 21st century.

New Challenges Presented by Smart City Architecture

One of the key means of achieving a smart city will involve the use of the right technology in its planning and operation. This means that technology must be applied without disturbing key drivers of societal balance such as employment, out of kilter demographics and patterns of immigration, urban economics and basic aspects of safety and security.

Technology can provide tremendous new opportunity, but it can also entail vulnerability if that technology is abused or applied in a dangerous or distorted manner and without adequate backup emergency provisions. If you have ever worried about hackers and techno-terrorists in the past, just wait. In a future created by smart city infrastructure and broadband networks there will be an even greater threat of hackers and black hat cyber-terrorists lurking on the dark web than ever before. The history of counter-counter intelligence has proven this to be so for a very long time. Some claim that the new 'block chain' technology is the ultimate cybersecurity solution, but history suggests that this is not so.

The latest and smartest technology can also potentially bring a threat to jobs and lead to unemployment or underemployment. A recent study by McKinsey and Company of automation and employment in the United States has concluded that: "Over the next 13 years, the rising tide of automation will force as many as 70 million workers in the United States to find new ways to make money."[1]

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[1] Danielle Paquette, "Study says automation could replace nearly a third of the U. S. workforce", *Washington Post,* December 1, 2017, p. A 13.

BENEFITS
- Better Planning &Economic Growth
- Less Pollution and Reduced Energy Consumption
- Better and Faster Infrastructure
- Less Commuting & Better Transportation Systems
- Reduced Traffic Accidents
- Better Crime Control
- Responsive Government Action
- Cost-Efficiencies & Competitiveness

CONCERNS
- Cyber-attacks
- Techno-Terrorists
- Vulnerable Industrial Controls
- Human-Machine Interface Weaknesses
- Maintenance & Updating
- Reduced Human Interaction
- Natural Disasters
- Reduced Privacy
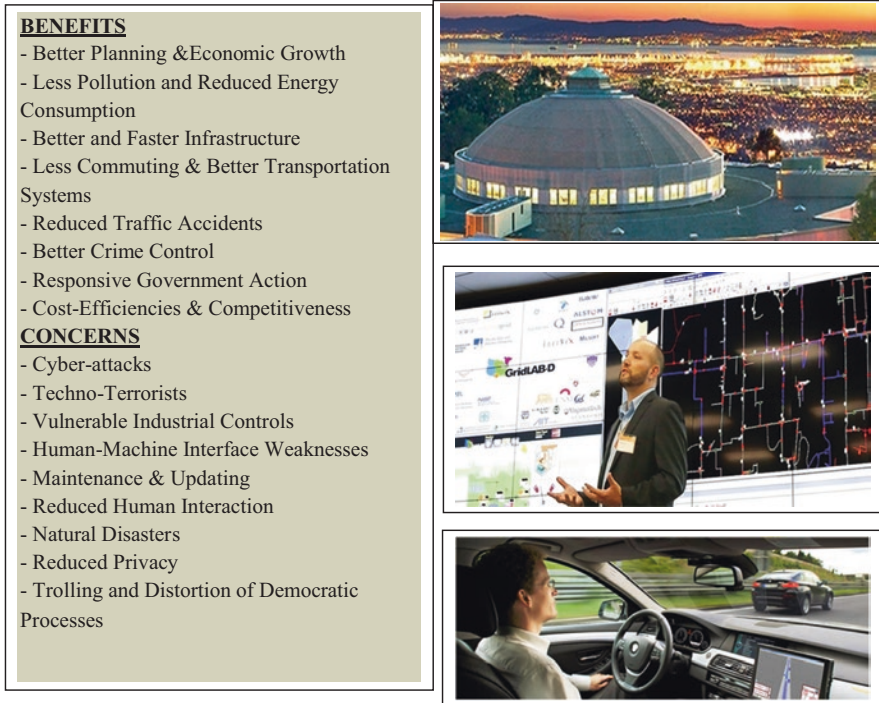- Trolling and Distortion of Democratic Processes

Fig. 1.3 Benefits and concerns associated with smart city technologies. (Source: Presentation by authors to Arlington County on March 14, 2018.)

This employment turmoil is due to what might be called super-automation,[1] a problem, of course, that extends not only to the United States but at least to all the developed countries such as members of the Organization of Economic Cooperation and Development (OECD). Vision and balanced goal-setting must seek an overall balance. Technology and automation are tools and not goals. The 21st century smart city must therefore involve thoughtful and balanced planning for the use and implementation of new technology, new infrastructure and better technology.

Figure 1.3 indicates some of the advantages and benefits of a smart city as well as some of the potential disadvantages to be guarded against.

This book explores the latest techniques and tools that make a modern smart city possible. It thus explores the latest in cybersecurity systems, new intelligent infrastructure and software. It also explores necessary administrative and political reform. We examine and even suggest some needed political, legal and regulatory systems to prevent the abuse of technology. In today's digital world it has become ever more difficult to employ smart system efficiencies while also defending freedom, privacy and liberties that are essential to preserving democracy.

Technical Challenges of Creating, Operating and Maintaining a Smart City

The technical challenges associated with a smart city today are enormous. It is ever more difficult to prevent cyber-attacks and find safe ways to employ the power of digital communications, cyber networks, information technology systems, artificial intelligence and advanced robotics. And these are just some of the key issues to be addressed in order to design, build and operate a smart city anywhere in the world. One can create a smart city anywhere. This is true whether it is in North America, Europe, the Middle East, Africa, South America, or Asia. Nevertheless, such a city must be conceived and adapted to its local culture and the needs of its citizenry, businesses, and national geography and its state of economic and educational development.

A true smart city must be planned on the basis of the right technology, the ability to adapt to changing demographics, education and health needs, employment, tax bases and adaptable infrastructure. New and sophisticated tools such as causal models, computer simulation runs and smart data analysis now makes such studies possible and likely outcomes predicted.

These key and integrated goals and objectives must consider dozens of vital factors, including safety, the degree of political, economic, and community cohesiveness, balanced employment, improved education and health services, vital and revitalized infrastructure and ultimately a social and urban design that can achieve all these objectives. These goals are not achieved through technology but by designing a smart city that is in harmony with its own inherent needs.

If the smart city is seen as a nail and technology is seen as the hammer, then the basic mindset is wrong. One must accordingly start with an organically developed and clear vision and then implement the goals and objectives. Technology must always follow those goals rather than create a paradigm that defines the future for technology's sake.

This harmony of basic smart city goals and objectives must mesh with the best digital technologies and smartware. Smart data must be employed that can help transform a city and apply the best technology in the best ways. The maxims, analytics and heuristic algorithms behind the effective use of smart data remain critical to any effort to create a better, safer and more intelligent city where people and neighborhoods thrive, technology is successfully deployed, and people are gainfully employed. When technology, effective planning and smart data are successfully analyzed and addressed, it can lead to a sense of true community. This means that social cohesion is nurtured, and smart practices and effective technologies can blossom across an entire city.[2]

There are many reasons why success is dependent on the wise and effective use of digital communications, artificial intelligence and information technologies.

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[2] "Smart Data—What Is It and How Is It Different?" https://mail.aol.com/webmail-std/en-us/suite. (Last accessed Dec. 18, 2017.)

Cyber-attacks on digital networks and individual devices are becoming more sophisticated each year. As we transition in the decades ahead to a world primarily populated by smart cities with universal digital access we will be faced with the paradox of a life filled with more services and amenities but also an existence that is exposed to greater cyber risks. Expanded digital services, properly deployed, can lead to improved, more accessible urban opportunities. They can offer a vista of enormous new possibilities in education, health care, transportation, energy, security and good government, but only if such technology is deployed to achieve clearly defined goals, and potential negative effects are countered.

Indeed, new technological advances offer us a myriad of breakthrough opportunities. Yet despite these wonderful new prospects we will very likely be challenged by new forms of cyber-attacks, data protection issues and what is techno-terrorism. Other concerns must include a clear-cut case for effective security, employment, responsiveness to concerns and changing demographics, ethnicity and incomes of the citizenry, and responsiveness of educational, health care, first responder and all other governmental services to the needs of all neighborhoods. Finally, we must be attuned to how digital technology becomes at times almost overwhelmingly pervasive to the extent that it threatens personal privacy and democratic governmental processes.

One of the most intriguing paradoxes posed by the smart city is the use of smart data and artificially intelligent systems in the design and operation of the next generation of smart cities. These technologies can help with the creation of smart infrastructure that allows us to build more efficient, less costly, cleaner and safer ways to operate a city. But one must be careful as to what one wishes for. Especially consider the longer-term consequences and constantly survey the populace to make sure that they feel progress is being made and that personal privacy is not overly invaded.

Artificially intelligent and highly automated streets, highways, bypasses, rail systems, energy networks and systems, water and sewer systems and more can lead to unexpected consequences. These consequences can be realized in terms of lower employment, higher risks of cyber-attacks, privacy concerns and totally unexpected new types of social, economic, taxation, business, and political concerns. A smart city always has its finger on the pulse of the community. This can lead to new efficiencies but also concerns related to democratic processes, privacy, employment and jobs and human fulfillment.

Concerns About Full and Meaningful Employment in the Smart City

Kai-Fu Lee, Chairman and CEO of Sinovation, a venture capital firm that specializes in artificial intelligence, has noted that the newest technology that is moving us toward driverless cars, completely automated manufacturing and more will spread to every sector of the economy. In time, this will include health care, education, engineering and the operation and functioning of cities. He has said: "Unlike the

Industrial Revolution it is not taking certain jobs….and replacing them with other jobs…Instead it is poised to bring about a wide-scale decimation of jobs…."[3]

As noted in the book *MegaCrunch: Ten Survival Strategies for the 21st Century,* most service jobs are currently being converted by smart software into tasks that can be performed by machines. This book strongly advises: "The time to start adapting to a new ecosystem where machine labor replaces much of today's employment around the world is now."[4]

This admonition applies not only to business and national governments but to urban governments as well. The big problem is no one has a feasible economic or employment plan that all agree with. Microsoft entrepreneur Bill Gates has suggested that there may need to be a sort of tax on those who create the tools of automation in order to pay a form of cost of living compensation to those who lose their jobs to advanced robots and software algorithms that can outthink most service workers—including municipal employees. The issue posed by smart cities is thus much larger than just cybersecurity to protect smart infrastructure and utilities against cyber-assault. There is also the question of what do humans do when smart machines perform most of the jobs?

In short, smart cities and expanded use of IT systems and artificial intelligence can bring a longer and safer life, new economic opportunity, even amazing new opportunities such as travel to other planets. But the technology that provides us new prospects can, ironically, also create new risks and pose new economic and political challenges. Current trends suggest that we will continue to move forward at an ever-faster pace to create smarter cities that can open up these new vistas. In this transition we will not only fully embrace the Internet of Things (IoT) but then move on to the Internet of Everything (IoE). In this new world, cyber defense will, at once, not only become more difficult but also more essential. The need to cope with cyber threats will increase at an exponential rate. Only automated and smart cyber defense will allow us to cope.

Living in the World of Tomorrow

This transition to the world of tomorrow will be everywhere. Not only in terms of driverless cars, smart vaccines and DNA therapy against disease but also in terms of automatic controls for virtually every aspect of the infrastructure of the smart city of tomorrow. This means machines and artificial intelligence will help make operations of virtually everything "smarter," i.e., transportation systems, the electrical grid, water and sewage systems and natural gas distribution. This will also be the case for buildings and houses. Everything within the next two decades will likely be 'smart'

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[3] Kai-fu Lee, "The Real Threat of Artificial Intelligence" *New York Times,* Sunday Opinion Section, June 25, 2017 pp. 3–4.

[4] Joseph N. Pelton and Peter Marshall, *MegaCrunch: Ten Survival Strategies for 21st Century Challenges,* (2010) PM Associates, London, U.K.

within modern buildings and homes, including all utilities, appliances and security systems. The trick is finding a way to make all of these intelligent systems reliable, safe, and risk-free against the assaults of cyber-criminals and techno-terrorists. The other trick is the redefinition of work and employment within these cities of tomorrow. We hope someday soon to find these answers, but to date no one has absolute answers to these problems. We would be lying if we said we had these 'magic' answers.

Recently experts in artificial systems, scientists and business entrepreneurs, notably Stephen Hawking and Elon Musk, have sounded the alarm against overly embracing artificial intelligence and intelligent infrastructure, especially in weapon systems. Some have even warned us against a future world that includes smart weapons systems that might be subject to hacker attacks. The use of smart weapons and intelligent defense-related devices are beyond the scope of this book. Nevertheless, this is yet another policy area that politicians and urban planners should be clearly aware of as well.

In short, although this topic is not probed in this book, AI in defense systems is another area of concern and interest that is important to the future. As we develop increasingly smarter IT systems, these types of concerns will be an area of increasing concern and interest.[5]

Therefore, we see an ever-growing need exists for more effective cybersecurity and defense systems against the abuse of IT systems in the smart cities of the future that are now possible to design, engineer and implement around the world. Some believe that this digital threat is increasing because cyber criminals are getting craftier, better schooled in hacking and have easier access to the latest tools because of the "dark web." And indeed, this is a significant and very real part of the problem. These cyber security threats will grow as usage of the dark web expands and access to malware becomes easier. This we know from decades of experience, that cyber criminals will continue to devise new ways to misuse IT and AI systems.

But the true key to the rapid growth in cybercrime is that the global digital ecosystem is itself fundamentally changing. This change is significantly being driven by the rise of smart cities and the expanded use of digital systems around the world. Some believe that the spread of smart cities is restricted to only a few of the world's most economically and technologically advanced countries. This is not the case. The governments of India and China, as well as dozens of other newly industrializing countries, are now spending many billions of dollars to create a myriad of smart cities. These are both new as well as totally retrofitted existing cities that are being transformed with an amazing array of services from tele-education, tele-health and on-line governmental services, to smart utilities, tele-security capabilities, "smart" power systems and intelligent transportation systems.

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[5] Peter Holley, "Artificial Intelligence Can Unleash 'Revolution' in Warfare Tech Leaders Warn" *Washington Post*, August 22, p. A14.

A New Digital Ecosystem

We are moving from a world where humans are not necessarily in charge. The digital world is more and more automated. This is the case because humans are too slow and are not able to handle the complexity that is associated with the smart city, where every second millions of decisions must be made, and soon that number will increase to billions.

In the new digital ecosystem, machines will be in charge of many aspects of our lives. Transportation routing, electrical power flows, lighting, water and sewage flows, operation of elevators and escalators, operation of traffic lights, and thousands of other transactions will be controlled by industrial control systems and artificial intelligent algorithms. These systems will be safer, more reliable and much more efficient.

The prime role of cybersecurity in this new world, where the Internet of Things morphs into the Internet of Everything, is to make sure that cyber-criminals and techno-terrorists do not take control of our digital machinery to do us harm or disrupt vital services. If we can keep the cyber-criminals in check, the smart cities can provide us with schools that are more efficient and reliable and better health care. We can have energy and transport systems that are environmentally more sound, effective, economical, and safe. One of the keys will be to provide safeguards. This is so that machines and AI systems are prevented—by such means as human machine interfaces (HMIs)—from doing damage to the safe and effective operation of the smart cities of tomorrow.

We are thus more and more living under a new digital ecosystem that is being shaped by the cloud, the architecture of digital networks, the Internet of Things, and increasingly smart automated industrial controls and supervisory control and data acquisition (SCADA) networks. With these machines and computer-based algorithms in charge of operations they can be more than a hundred times more environmentally sound and efficient. The hitch is that key aspects of digital defense must be significantly rethought.

This book is about the new digital ecosystem that will represent the "brains" of smart cities. We will explore new methods and procedures for coping with new types of digital risks. We will help to explain new strategies for undertaking cyber-defense in this new largely automated world. It is not possible to mount effective cyber defenses without understanding this fundamental shift in what we call the new digital ecosystem. This new approach to digital defense must become part and parcel of the smart city of tomorrow.

When Is a Community a Smart City

The Intelligent Community Forum, with its headquarters in New York City, has recruited a global network of judges that each year designates 21 cities as intelligent cities. These are then narrowed to the top seven and ultimately one overall top winner is chosen.[6]

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[6] The Intelligent Community Forum March 2018, www.intelligentcommunity.org.

Some of the criteria that the Intelligent Community Forum uses in this selection process include the following.

Sufficient Broadband Networking Services

The judges consider whether there are readily available broadband networks sufficient to support governmental, medical, health care and school systems as well as private households and commercial enterprises. This evaluation process considers at what cost services are provided and under what operational conditions—including whether there are, for instance, competitive systems.

Smart Public Transit and Automotive, Rail and Air Transportation Systems

This evaluates the quality and extensiveness of coverage of public transit systems as well as the nature and intelligence of automotive, rail, air and bicycle transit systems in terms of their controls, responsiveness to changing patterns of use throughout the day and week as well as their security.

Smart and Versatile Power Systems and Degree of Sustainability

The viability of networked services depends heavily on reliability of electrical power systems and the back-up capabilities for emergency services such as 911 call centers. A key concern is whether the electrical power system is secure against hacker attacks.

Effectively Managed and High-Quality Utility Services (i.e., Water, Sewage, Gas, etc.)

The modern smart city must not only have all types of key infrastructure related to utilities (i.e. water, sewerage, gas, and electricity) operating at maximum efficiency, using effective and protected industrial controls (i.e. SCADA or Supervisory Control and Data Acquistion), but these must operate under effective security measures and back up control systems.

High-Quality Educational Systems

The viability of a community—especially in terms of its political, economic and cultural future—depends on a quality educational and training system geared to the needs of its population.

Improved Health Care Systems

A community is heavily dependent on a quality medical care, health care, sports and athletic programs that allow its citizenry to remain healthy.

Community Spirit and Political Processes to Increase Citizen Input in Decision-Making

The development of new and capable IT infrastructure and software that ensures its effective operation is key, but a political process that allows the definition of systems that allow a city to operate effectively and meet civic objectives is at the heart of a true smart city. A city without effective citizen input and strong support for creating a better future for its entire citizenry will likely not succeed in the longer term.

Housing, Jobs and Employment

Other key aspects of a successful city are those capabilities and efforts aimed at improving and increasing available housing, jobs and meaningful employment, and fiscal stability as well as achieving sustained financial and economic growth. These represent key indices to monitor in order to assess the how smart technologies are helping to create a better city and a better future.

Fiscal Stability, Quality of Financial Planning and Economic Expansion

Closely linked to jobs and employment factors are financial well-being and sustainable growth based on a vibrant economy and a viable tax base. This requires an optimum balance within a community. A desirable urban condition is where there is some growth and expansion but not at excessive rates. Population growth at greater than one to two percent per annum can be increasingly problematic. Many of the world's

largest cities, particularly megacities of ten million or more inhabitants, have exceeded the size associated with sustainable growth and the ability of urban infrastructure to expand to meet overheated demand. The transition from overcrowded megacities to broadband-linked meta-cities is one way to make the cities of the future smarter.

Effective and Secure Automated Control Systems for All Infrastructure

Automated industrial control systems (such as so-called SCADA networks), computer software algorithms, robotics, and artificial intelligence can improve efficiency, reduce the cost of government, and allow the smart city to blossom. These automated systems can help to optimize energy efficiencies, relieve rush-hour conditions, improve transportation systems, deliver more effective utility services, and much more. But such systems must be secure against cyber-attack and geared to the needs of the citizenry, or these automated systems will ultimately fail in their mission. In the smart city security is increasingly important and essential to ultimate success.

Artistic, Cultural and Library Services

Some urban leaders look to their success and find it in controlling finance, budgets and taxes, but in a true smart city the objectives need to be broader. Success in all of the above criteria need to be supplemented by attention to needs related to the arts, culture, sports and athletics, libraries, and citizen involvement in their community. These factors can be equally key to a smart city. Controlling infrastructure, taxes and financial expenditures is just one aspect of success within a smart city.

Sustainability of Growth and Development

Balance is everything. A smart city will ultimately succeed in the longer term if it has a sustainable arc to the future that allows it to succeed in all its key dimensions. These include economics, employment, population growth, housing, health and education, political governance, citizen involvement and cohesion, efficient infrastructure for utilities, transportation, communications and IT systems, and more. These need to expand to meet citizen needs and still provide a healthy and sustainable environment while also remaining secure and peaceful. Most of all, this means creating a circular economy. Such an economy minimizes the waste of resources and pollution and abandons the principles of a linear economy. Such a linear economy is based on continuous throughput and the so-called 'take, make and dispose' model of production.