The Chicago Council on Global Affairs

# EMERGING LEADERS PERSPECTIVES

Global Era • Different Challenges • New Priorities

EMERGING LEADERS SERIES

The Emerging Power of Big Data: The Chicago Experience

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June 2014

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# Foreword

Big data is a phrase that we hear regularly these days, but in the course of examining the role of technology and data analysis in cities around the world, the Emerging Leaders realized the term was not always well understood or used in a consistent manner. As they dug deeper into the issue of big data, they discovered the many hurdles that local, state, and national governments will have making the most of this new capability. They saw that this was an important issue for all cities around the globe and decided to highlight good examples in the use of big data and tackle some of the key issues that could produce problems. In the end, they provide recommendations that any city could use. The Emerging Leaders Class of 2014 shows vision and leadership with this report and their look at how Chicago and other cities can use big data to make significant improvements in the lives of residents.

The amount of data collected globally every day is astonishing. Individuals generate data every time they go to school, shop with their credit cards, turn on their cell phones, use their electricity, pay their taxes, call their elected officials to complain, and visit the doctor. Until relatively recently, this quantity of data was more than the computing, transmission, and storage systems could handle. However, that has all changed, and we are now in the era of big data.

Around the globe cities are not only generating more data, but also using them for better decision making. Residents are calling for more transparency from their leaders. However, not all cities are equipped with the talent, resources, or political will to analyze massive amounts of data and make them available to the public. Yet, if a city is going to stay globally competitive and attract the best talent, it will have to make big data part of its mental and physical infrastructure.

Big data has great potential and numerous possible pitfalls. Issues of privacy and profiling are of great concern. Governments also must resist the temptation to "govern by spreadsheet." Big data is an important new tool for cities to use, but data do not generate solutions.

The members of the Emerging Leaders Class of 2014 bring to the table a strong commitment to the future of our city and diverse perspectives on how to address global challenges. They are part of an environment in Chicago that is receptive to and known for inno-

vation. They are encouraged by Mayor Emanuel's commitment to effectively using big data in Chicago and are confident that Chicago can become a global leader in this area.

The class has proposed thoughtful, concrete steps that have the potential to make a difference in our community and serve as a model for other communities confronting similar issues. More importantly, the potential for millions of people around the globe to benefit from their work and the support of many who helped them along the way gives us reason to be proud and confident in the commitment this group has made to The Chicago Council and to the City of Chicago. I am delighted that the Emerging Leaders want to take the opportunity to convert thinking into action with this report.

## The Emerging Leaders Program

The Chicago Council on Global Affairs' Emerging Leaders Program is a two-year program that draws the best and the brightest emerging leaders from across business, civic, government, and academic sectors in the Chicagoland area. The program provides the Emerging Leaders (ELs) with a deeper understanding of global issues and Chicago's place in a globalized world. ELs also develop a strong network of contacts with current civic and business leaders and, perhaps more importantly, with their Chicagoland peers, who are also grappling with global challenges. In short, they emerge better prepared to assume key leadership positions in this new era.

## Acknowledgments

The 22 members of this class all contributed over the course of two years to the discussion and debate in the development of this topic and report. Throughout the second year they were briefed by experts in Washington, DC, and Chicago who are equally committed to the effective use of big data. I want to express the Council's gratitude to the following individuals for taking time out of their busy schedules to brief this group and share their experiences and views: Elaine Allensworth, Lewis-Sebring Director, University of Chicago Consortium of Chicago School Research; Roseanna Ander, executive director, University of Chicago Crime Lab; George Aye, assistant professor, Architecture, Interior Arch and Designed Obj (AIADO), School of the Art Institute of Chicago, and cofounder, Greater Good Studio; Brenna Berman, chief information officer, City of Chicago; Mike Berman, legislative assistant, Office of Representative Mike Quigley; Chris Clavin, researcher, Science and Technology Policy Institute (IDA); Gregory M. Darnieder, senior advisor to the secretary on the College Access Initiative at the US Department of Education; Evelyn Diaz, commissioner, Department of Family & Support Services, City of Chicago; Jason Gallo, researcher, IDA; J. Erik Garr, principal, PWC; Brian Giglio, vice president for external affairs, RR Donnelley; Richard Harris, research specialist, University of Chicago Crime Lab; Brad Henderson, partner and managing director, BCG; Hudson Hollister, executive director, Data Transparency Coalition; Kristen Kulinowski, researcher, IDA; Bhavya Lal, researcher, IDA; Blair Levin, executive director, GigU, and Communications and Society Fellow, Aspen Institute Communications and Society Program; Commander Jonathan Lewin, managing deputy director, Public Safety Information Technology, Chicago Police Department; Mark J. Lewis, director, IDA; Nathan Hess, associate researcher, University of Chicago Crime Lab; Paul Linden, Hindex; Joel J. Mambretti, director, International Center for Advanced Internet Research, Northwestern University; Joseph G. Magats, deputy chief, Criminal Prosecutions Bureau, Assistant State's Attorney Office; Daniel X. O'Neil, executive director, Smart Chicago Collaborative; Kathryn L.S. Pettit, senior research associate, Metropolitan Housing and Communities Policy Center, Urban Institute; Alan Raul, partner, Sidley Austin LLP; Aaron Renn, founder, Urbanophile and Telestrian; Dan Rosenbaum, research specialist, University of Chicago Crime Lab; Tom Schenk Jr., director of analytics and performance, City of Chicago; Gary W. Schenkel, executive director, Office of Emergency Management and Communications, City of Chicago; Dylan Sodaro, staff assistant, Office of Representative Mike Quigley; Yanev Suissa, New Enterprise Associates; John Tolva, former chief technology officer, City of Chicago; Chris Weber, researcher, IDA; and Rebecca Williams, policy analyst, Sunlight Foundation.

Council staff Rachel Bronson and Molly O'Donnell worked with the group providing guidance, motivation, resources, and support throughout the two-year process. Catherine Hug of Chicago Creative Group edited drafts of the report.

None of this great work would have been possible without the vision, leadership, and support of John F. Manley and Shirley Welsh Ryan, both vice chairs of The Chicago Council's Board of Directors and cochairs of the Emerging Leaders Program. They, along with the other members of the Emerging Leaders Selection Committee put enormous amounts of time into selecting the members of this class.

Their efforts have resulted in another great group that The Chicago Council is proud to have as Emerging Leaders.

Our sincere appreciation goes to the Robert R. McCormick Foundation and the Patrick G. and Shirley W. Ryan Foundation for their continued contributions.

Ivo Daalder
President
The Chicago Council on Global Affairs
June 2014



# Executive Summary

## Chicago as a case study—A rising megacity with a plan to incorporate big data

This report begins to tackle the question of how to leverage big data analytics in municipal and government decision making by looking at the experience of the City of Chicago. On the list of cities projected to become new megacities, i.e., cities with populations greater than 10 million by 2025, Chicago is the only one in the developed world. In 2013 Chicago Mayor Rahm Emanuel proposed a comprehensive plan for employing technology to improve the local economy and the quality of city services. This creates a valuable lens through which to study the emerging opportunities for cities to embrace the power of big data to improve the lives of their residents.

## Urbanization and big data

As urbanization continues worldwide, the influential role of cities in the global economy is increasingly evident. As city populations rise, the data generated by residents and city operations are also rapidly growing. At the same time, the ability to collect, analyze, and utilize data for decision making is increasingly enabled by the prevalence of personal devices, increased connectivity, accessibility to high-performance computing and storage, and advanced analytics. While these trends offer great opportunities for cities, significant barriers also exist. How does a city begin to think about big data?

## Sectors with big impact

Big data has the potential to transform every aspect of the lives of residents around the world. In particular, decisions driven by the analysis of multiple data sets can enable cities to be more efficient and effective in delivering services to their residents and stakeholders. As more and more people around the globe move to urban areas, cities need to embrace big data to improve the delivery of goods, depth of services, and the quality of life and to allow these offerings to scale with population growth.

Given the complexity of cities and their operations, we have chosen to focus on four sectors that have significant potential to benefit from the big data revolution and where early action can offer substantial benefits:

- Energy
- Transportation
- Education
- Public safety

## Energy: Enabling smart, distributed systems to create a more energy-efficient city

Many energy conservation initiatives are only possible through the collection and analysis of diverse sets of information. Today, much energy is wasted due to ineffective management and distribution of power. "Smart grids" offer the ability to improve the utilization of power, increase efficiency, and decrease costs, while matching capacity and distribution to energy needs. Yet while the potential is promising, the capture and analysis of big data are key to the success of the smart grid. Eventually, as more data become available and smart grids develop, we expect to see significant changes in both supply and demand that will increase reliability and reduce costs and environmental impact.

## Transportation: Improving the flow of people and goods through monitoring and prediction

The interdependency of diverse players complicates the ability to effectively manage and streamline the transportation of people and goods throughout a city. The greater Chicago metropolitan area—home to one of the world's largest trade centers, the nation's second-largest public transit system, and 9.5 million residents—is a prime example of this interconnectedness. Initiatives such as the "Train Tracker" application for smart phones and dynamic models for public transit routing leverage sensor infrastructure and predictive analytics to better understand and predict human and traffic patterns. Such solutions can help decrease disruptions in service and lead to better management of large and complex transportation systems.

## Education: Adapting and customizing solutions to improve education outcomes

By harnessing data mining and applied analytics, big data in education can greatly increase the quality of instruction, monitoring, evaluation, and accountability. Plagued by poor graduation results and test scores, the Chicago Public School System (CPS) has recognized that big data can enable the creation of customized solutions needed to change these historical challenges. Rapid analysis of multiple data sets is needed to understand drivers, make meaningful and timely adjustments, and thereby address critical gaps in school and student performance, student safety, and job preparedness. Through public-private partnerships, Chicago has leveraged the academic, business, and nonprofit communities to provide data-driven solutions and improve educational outcomes.

## Public safety: Integrating data analytics to improve crime prevention and enforcement

Facing a recent surge in violent crimes, Chicago is employing big data to better coordinate responses, provide social services, understand the criminal landscape, and quantify outcomes. By centralizing command and control of law enforcement and public safety agencies, the city is able to aggregate complex data and utilize analytics more effectively. Additionally, tremendous strain on the system results from the influx of new residents into a city. This strain causes an increase in the potential for crime and the cost of crime prevention and enforcement, as city budgets decline. Big data has helped law enforcement create "social networks" that, for example, identify individuals who are more likely to be crime victims and thus allow for better targeting of prevention strategies.

## Balancing challenges and opportunities

As the report outlines, the promise of big data applications in these four sectors is accompanied by a number of barriers and concerns, ranging from data interoperability and security to cost and privacy issues. Big data is a large and complicated subject, and its use can have implications that reach far and wide. To facilitate actionable and achievable solutions, we have identified a number of pillars

for success based upon the Chicago experience that can help cities develop big data strategies:

- Lead big data initiatives from the top.
- Collect appropriate and quality data.
- Ensure data sharing, public access, and collaboration.
- Put safeguards in place for data security.
- Address privacy concerns.
- Gain public support.
- Fund outcome-based evidence on what works.

If city governments and their private-sector and nonprofit partners embrace these seven pillars, we assert that a robust big data strategy may improve the lives of residents, while achieving meaningful and sustainable competitive advantages.



# Introduction

The rise in importance of the city as the organizational unit of human life and the proliferation of data as a result of the ever-growing role of information technology in our lives are two of the more significant trends to have emerged in the second decade of the new millennium. The confluence of these two trends is at the core of an exciting new set of possibilities for cities and their residents.

In many ways cities are the future of economic growth, innovation, and human interaction. In 2008 the world reached an invisible and momentous milestone: For the first time in history, more than half of the human population, 3.3 billion people, lived in urban areas. By 2030 the numbers are expected to reach almost 5 billion.[1] In as few as 35 years from today, as many people could be living in cities as lived on the entire planet just 10 years ago.

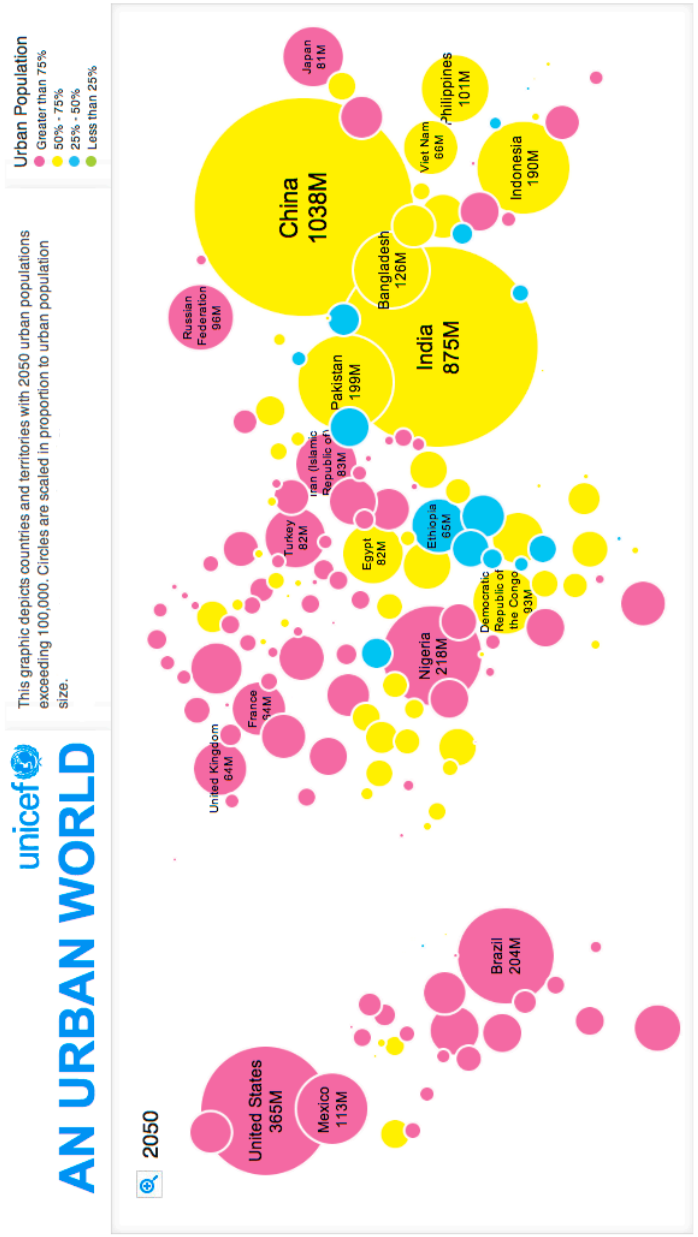
The growing use of technology in many aspects of our lives has resulted in an explosion of data that details who we are, how we live, and what we do. From education to employment to consumption to community, information on the workings of society and its people abound.

With so many people concentrated in urban areas, it is perhaps not surprising that cities generate a large portion of the world's data. This trove of data is a potential mother lode of information and intelligence for city planners and other civic officials. For many years, the volume and complexity of such data, dubbed "big data," made it impossible for then-current analytical methods and processing technologies to make sense of it. In recent years, however, the development of increasingly sophisticated computer algorithms has allowed large, disparate data sets to be integrated and analyzed. The resulting big data revolution is making cities smarter, safer, and more prosperous.

Cities cannot live, however, by data and algorithms alone. While big data has the potential to dramatically improve our lives, there are also dangers to its improper use. Keeping this data secure from hackers and protecting against invasions of privacy are perhaps the most pressing challenges. All residents have a huge stake in the crafting of the big data revolution, its direction, and its ultimate ability to impact the future.

1. National Intelligence Council, *Global Trends 2030: Alternative Worlds,* December 2012, http://www.dni.gov/files/documents/GlobalTrends_2030.pdf.

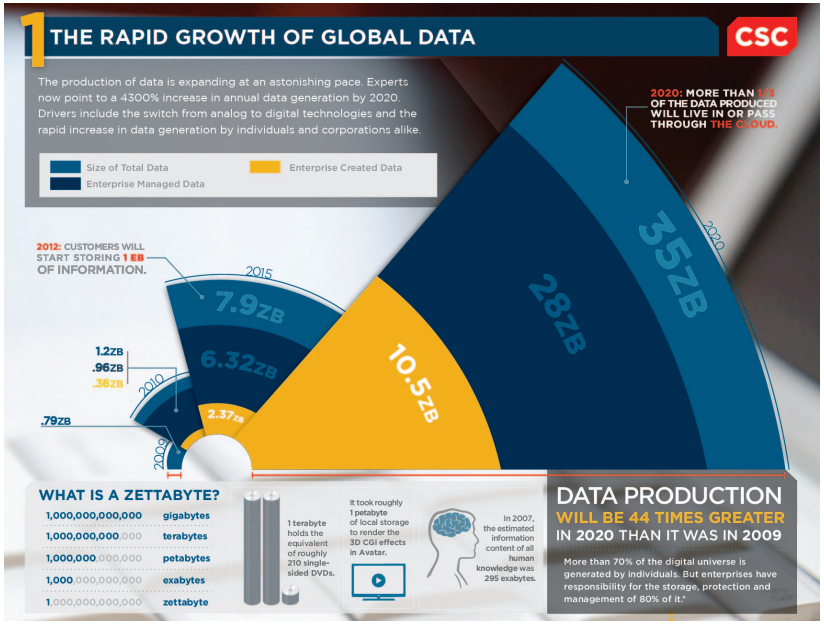
**Figure 1 – Projected urban population by country in 2050**




Source: Unicef, *The State of the World's Children*, 2012, http://www.unicef.org/sowc2012/urbanmap/#.



**Figure 2 – The explosion of data**




* IDC Digital Universe Study, sponsored by EMC, May 2010. Chart makes conservative assumption that enterprise will continue to generate 30 percent of data while being responsible for 80 percent.

Source of illustration: Computer Sciences Corporation, 2012. Sources of data: IDC/EMC 2011 Digital Universe Study, 2010 Digital Universe Decade Study, Data rEvolution, Sept. 2011, CSC's leading Edge Forum.

## The Emerging Leaders Class of 2014

The question of how big data can help cities govern and grow in a more effective and efficient manner is at the core of inquiry for the Emerging Leaders Class of 2014. This report identifies ways in which big data can be used to address potential municipal policy issues. Exploring these opportunities is important to the future of cities in the fast-moving global world where cities and big data collide.

The Emerging Leaders Class of 2014 believes the time is ripe for an assessment of our own city and its use of data. Chicago is an interesting case study because of its strong history on the forefront of technology and currently on the collection and analysis of big data to affect change. By surveying Chicago's use of big data and discussing some of the successes and challenges, we can mile-mark our own progress in the globally competitive landscape of urban envi-

ronments and contribute to a dialogue among cities of all types and locations on this important topic.

In this report, the Emerging Leaders 2014 cohort looks at where and how data is currently being used in municipal governance as well as its efficacy. At a time when many cities continue to face budget shortfalls, one of the potential promises of big data is to help government do more with less.

Much theoretical and practical ink has already been expended on the analysis of big data on a global basis. We assert that a specific look at a single city and its core services in relation to developments in big data can contribute to the local and global discussion of how to tap its potential for the good not only of Chicago but cities around the world, including those in developing countries who are at the beginning stages of this work.

For this study we have carefully selected what we believe to be the four pillars of urban governance:

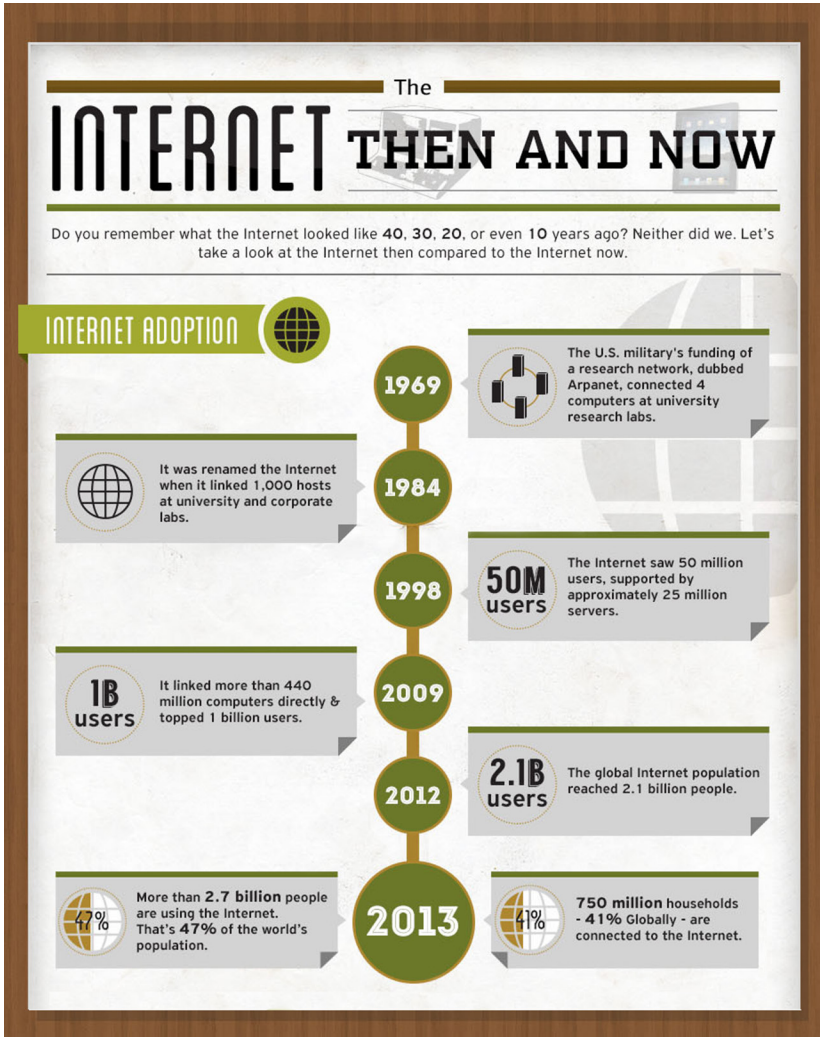
- Energy
- Transportation
- Education
- Public Safety

The initiatives and potential of big data in these areas are discussed in the following chapters. We acknowledge that urban infrastructure is also a hugely important component to this work. While it is addressed to some degree in the sections on transportation and energy, it has not been singled out as an area for analysis.

The growth and importance of big data is a trend that is not going to go away. If anything, as we evolve into a world where "the Internet of things" (the advanced connectivity of devices, systems, and services) is the norm, cities will need to embrace big data as a matter of practicality. Big data is a large and complicated subject, and its use can have implications that reach far and wide. To help cities orient their thinking on big data, the 2014 Emerging Leaders have identified actions necessary for a city to successfully use big data. These are discussed in the final chapter.

Finally, we believe that the promise of big data is great, even—and perhaps especially—during difficult times when resources are scarce and budgets must be cut. However, we hope that the "connectivity" of residents and leaders today enables them to ask better questions and (ideally) affect better outcomes. Indeed, it is not

**Figure 3 – Growth in Internet usage since its inception**




Source of illustration: WhoIsHostingThis.com, "The Internet: Then and Now [Infographic & Video]," http://www.whoishostingthis.com/blog/2013/06/17/internet-then-and-now/. Source of data: PCWorld.com; Itu.int; Royalpingdom.com; Statisticbrain.com; Searchengineland.com; Thenextweb; Uncp.edu; Youtube.com; Dailyinfographic; Jeffbulas.com; Statista.com; Madmobilenews.com; Pewinternet.org; Wikipedia.org.

despite these challenges but because of them that there is an urgency for action on the use of big data in Chicago and around the globe.

In general, the growth and proliferation of the Internet is the backbone on which much of the more recent developments in data collection, sharing, and analytics can and have taken place. To that end, it is worth noting the Internet's recent growth trajectory (figure 3) and imagining what such dramatic growth may mean for the use and implementation of urban-based big data in the future. Metcalfe's law provides a broader view of the theoretical ideas at play. This "law," suggested in the early 1980s by Robert Metcalfe in relation to Ethernet and further articulated by George Gilder in 1993, says that the value of a telecommunications network is proportional to the square of the number of connected users of the system ($n^2$).



# Chapter 1

## Big Data and Cities

"Big data" is a fairly new buzzword, though as a concept it is not entirely new. While there is no universal definition, big data generally refers to sets of data of a size and complexity for which current analysis methods and processing technologies are not sufficient. In 2011 Google searches for the term "big data" started to become part of the zeitgeist, and the term continues to grow in use and popularity today (figure 4).

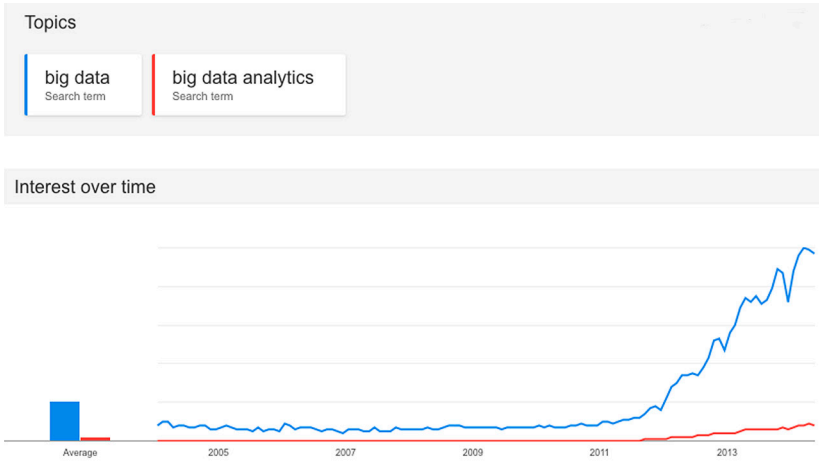
The use of big data is wide ranging, from personal to private-sector and public-sector applications. One of the largest global examples of the use of big data is the Large Hadron Collider (LHC) at the European

**big data**

*noun (used with a singular or plural verb) Computers.* Data sets, typically consisting of billions or trillions of records, that are so vast and complex that they require new and powerful computational resources to process: *Supercomputers can analyze big data to create models of global climate change.*

Source: Dictionary.com, *Dictionary.com Unabridged,* Random House, Inc., accessed May 13, 2014, http://dictionary.reference.com/browse/big data.

**Figure 4 – Google searches for "big data" and "big data analytics"**




Source: Google Trends, http://www.google.com/trends/explore#q=big%20data%2C%20big%20data%20analytics&cmpt=q.

Organization for Nuclear Research (CERN).[2] The LHC is a particle accelerator that generates so much data that scientists are able to use it to study the origin of the universe. On a more local and practical scale, retailers use big data to better understand their businesses and thereby improve efficiencies and operating margins.[3] For example, using big data, retailers are able to better understand how their customers' online searches result in offline sales.

In theory, more and better data should help decision makers at all levels make better choices. Time and cost efficiencies are important measures of the uses of big data. In many cases big data can have significant and immediate impact. As we become an increasingly connected world, there will only be more data generated. Those who successfully leverage this data—whether individuals, the private sector, or the public sector—will have the greatest competitive advantages in the future.

## Why cities?

Cities are the global laboratories for innovation in delivering services to residents and often serve as models for other cities and national government services. Since big data is ultimately about the information generated in our technological age by people, and cities are where more and more people live, cities are where most big data is generated and where its greatest impact can be realized. Cities are therefore increasingly looking to big data to help them improve services and governance and take advantage of its potential to improve efficiency and efficacy.

In the recent past, the term "smart cities" has been popularized to convey the idea of cities using technology to become "smarter" in their delivery of services. There has been a growing recognition that as technology develops, governmental organizations need to stay atop of trends because of the potential importance technology can have on the issues that matter the most to residents. Big data, then, becomes the input and output for the technology-enabled smart city as it seeks to understand statistics and information about anything and everything under its purview.

2. CERN FAQ, "LHC the guide," 2009, accessed May 13, 2014, http://cds.cern.ch/record/1165534/files/CERN-Brochure-2009-003-Eng.pdf.
3. James Manyika, et al. "Big data: The next frontier for innovation, competition, and productivity," McKinsey Global Institute, May 2011, http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation.



## Challenges and opportunities

A number of exciting opportunities for the use of big data are looming on the horizon (figure 5). As cities generate more and more data each year, the number of data sets for use and analysis will expand. This expansion of available data has profound implications for the future success of big data initiatives. Provided cities make data easily accessible to researchers, planners, and law enforcement authorities, the possibilities for future applications of big data are seemingly boundless.

Increases in computing power, too, will have a tremendous impact on the ability of big data to play a role in helping cities. As computational power becomes more sophisticated, big data may be able to move from analyzing issues to playing an active role in their resolution. Yet challenges also abound. Issues of privacy, cost effectiveness, compatibility (interoperability) of different data sets, data security, and social implications all will need to be effectively addressed. These challenges are discussed throughout this report.

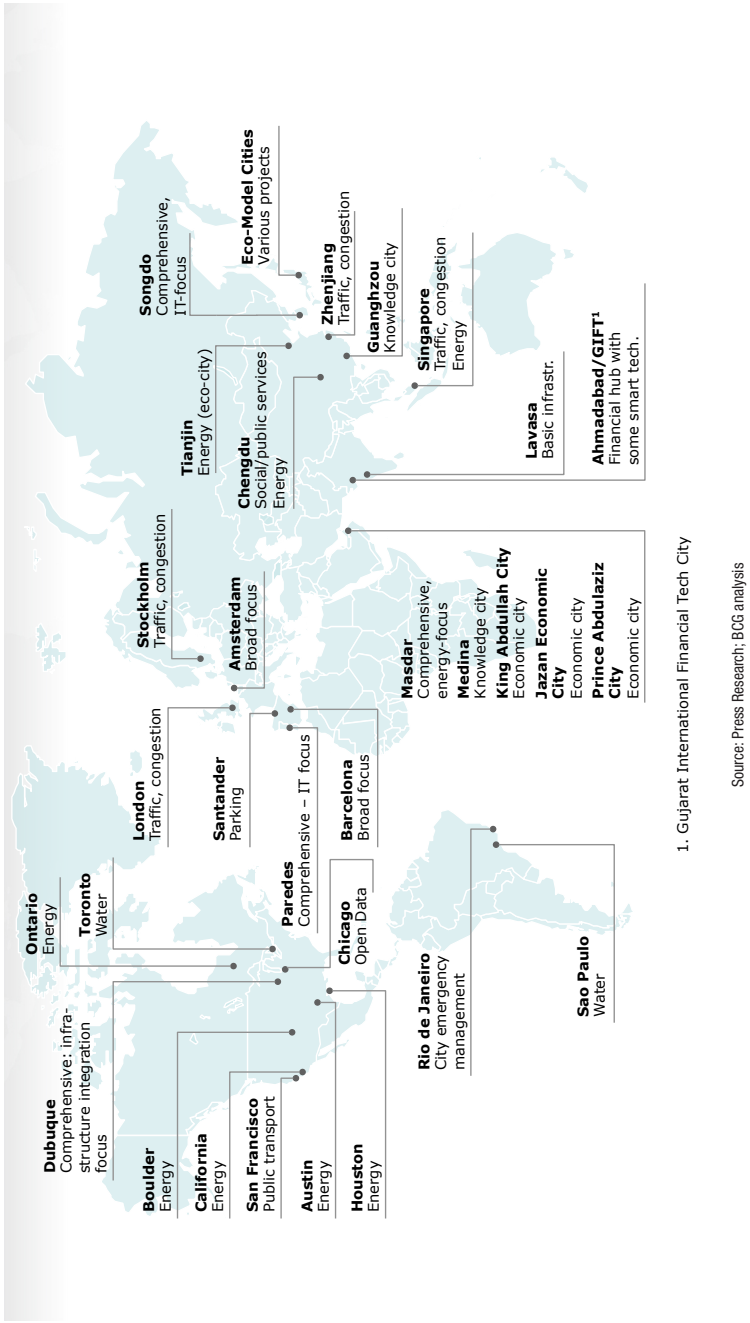
## Why Chicago?

Chicago is a good case study for why big data is useful and important because it has embraced the use of big data as a path to improving the city and the quality of life for its residents. The city has already made great strides on many fronts. The city has recognized that a more efficient city is a more competitive city, and a more competitive city attracts and retains the much-needed talent to offer the best opportunities to its residents. It is a positive feedback loop. Chicago's ability to continue to grow and thrive as a municipality will dictate whether or not Chicago continues to be a competitive global player. Data collection and analysis married with governance will deeply affect the future of the city.

Chicago has a strong history of being on the forefront of technology. From reversing the flow of the Chicago River to being the birthplace of the skyscraper and home to numerous technology start-ups, Chicago knows technology. Chicago is a hub for key Internet trunk lines and is also now on the forefront of data collection, analysis, and action. Chicago is a good example of a city that has identified and embraced big data.

In 2012 Chicago Mayor Rahm Emanuel became an outspoken proponent of "open government." Through an executive order,

**Figure 5 – Many cities are using big data to pursue and optimize municipal projects.**




1. Gujarat International Financial Tech City

Source: Press Research; BCG analysis

## Box 1– Making Chicago's data available through a new data portal

Since 2010 the City of Chicago has made its data portal available as a web-based online data and information tool. The site hosts over 200 data sets in key categories, showing city performance in many departments and facilities and allowing access to the data captured and used by government. The portal encourages users to develop interactive tools to serve the community, including "open source" availability and means. The data portal has also become a means for viewing related data projects that the city has implemented or that are in planning.

his administration required each city agency to make "reasonable efforts" to collect and make available all appropriate data on the city's data portal. This effort was not just about making government more transparent, but about changing the way we think about data and how they are used by a city to better serve residents. The mayor realized that better access to and analysis of data could help his administration make more informed decisions, which in turn serve the public good.

In 2013 the mayor released an ambitious technology plan for the City of Chicago.[4] According to the mayor, this plan "will allow the city to maintain its leadership in technology and build on a commitment to modern infrastructure, smart communities, and technological innovation."[5] The plan's list of benefits are shown in figure 6. This plan was a unique innovation compared to prior plans insofar as it created a cabinet-level position to identify data already being generated, integrate those data into city operations, and share data more broadly with constituents.

In addition to being a center of technology, Chicago is also one of the world's transportation hubs. O'Hare and Midway Airports offer direct flights to countries around the world. Chicago is well positioned to leverage the power of big data, then spread best practices around the world.

Finally, the Chicago area is home to world-class educational and research institutions. Top-ranked institutions include the Illinois Institute of Technology, the University of Chicago, and Northwestern

4. See http://techplan.cityofchicago.org.
5. See http://www.cityofchicago.org/city/en/depts/mayor/press_room/press_releases/2013/september_2013/mayor_emanuel_releasescityofchicagosfirstevertechnologyplan.html.

**Figure 6 – The City of Chicago's view of how the city can benefit from technology**

| WHEN THE CITY... | CHICAGO BENEFITS FROM... |
|---|---|
| Employs new technology and data to improve government processes and services... | better, smarter, lower-cost government operations, services, and information. |
| Encourages civic innovation... | the power of an engaged society that helps identify and solve problems, both independently and collaboratively, with city government. |
| Engages and educates residents and businesses in technology to make every community a smart community... | the quality of life, employment opportunities, and business growth made possible by full participation in the digital economy. |
| Helps make world-class broadband and Wi-Fi available to business and residential communities, including currently underserved neighborhoods... | a technologically-savvy population that encourages investment, education, and engagement. |
| Encourages and supports growth in the Technology Sector, including Web/ Mobile, Bioscience, and CleanTech... | the creation of new jobs and the expansion of the City's STEM-trained workforce. |

Source: 2013 City of Chicago Technology Plan, http://techplan.cityofchicago.org.

University, among others. These institutions are critical to the city's ability to develop new technology and graduate quality students in science, technology, engineering, and math (STEM) who can organize and analyze big data to make it useful. These institutions also put educated workers into the local workforce and act as catalysts for future technology start-ups.

The following chapters highlight Chicago's experience with big data in the areas of energy, transportation, education, and public safety. This experience helps show that a concentrated focus, combined with energized residents, can produce impressive results.



# Chapter 2

## Big Data and Energy

Cities provide a host of basic services to residents such as water and sewage services and road construction and maintenance, to name a few. In addition, they play a pivotal role in formulating and facilitating energy policy. The use of big data holds the promise of making such services more reliable, in turn making cities better places to live. When cities and consumers can see water, energy, and traffic usage in real time and react accordingly, they can mitigate outages and prevent problems before they occur. Stakeholders can better balance resources and potentially deliver a higher quality service at a lower price.

Providing energy—or more specifically for our purposes, electricity—is a unique challenge. Since electricity cannot be stored, a system based on peak capacity is required. This means that on any given day the entire system must be able to provide enough energy to meet the needs of the highest demand day of the year (which usually falls in the third week of July). This is obviously highly inefficient.

### The potential of smart grids

The smart grid, and big data more generally, present clear opportunities for utilities that serve cities such as Chicago to build a more nimble, efficacious energy infrastructure. A smart grid is a modernized electrical grid that uses information and communications technology to automatically gather and act on information—such as the behaviors of suppliers and consumers—to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity. A smart grid in its best application serves as a sort of air-traffic-control system—it dispatches power from the appropriate source at the appropriate time and even anticipates demand. As a result of providing information and systems that increase reliability and decrease demand, the smart grid eliminates the need for excess capacity and better utilizes existing assets, all of which will ultimately result in lower consumer costs.

As one can imagine, a smart grid collects masses of information, which is where big data comes into play. In the case of smart grids, big data refers simply to the collection and analysis of massive amounts of data on both the consumption and generation of energy.

### Improved energy usage

Two potentially important smart-grid applications for cities are "demand response" and "distributed generation" systems. An effective demand response system allows utilities to reduce or eliminate noncritical power demands during peak usage times. For example, your utility would be able to turn off, or down, things in the home that are not needed while you are away at work. This calibration would allow the system to deploy less power generation, thus reducing both the costs and environmental impact.

A distributed generation system generates electricity from multiple small sources such as solar panels or wind turbines to provide alternative or supplemental energy to the centralized power grid. For example, consumers would use their own power for a portion of time, but when they generated more or consumed more, they could sell or buy directly to or from the grid. These smaller power sources can be initiated and managed to give greater reliability to the network. Since a more reliable network is a more efficient network, both demand response and distributed generation systems result in a more efficient total use of the available energy infrastructure.

### Better resource allocation

Another key use for big data in electricity provision is better resource allocation. There are a variety of ways in which more data on real-time events can help create a better, more efficient electricity grid. Utilities that have installed advanced metering infrastructure (AMI) technologies, for example, can gain invaluable data and address problems, often before customers even notice. One type of AMI is a smart meter, an electricity (or sometimes natural gas or water) meter with real-time sensors that detect power usage and outages. Smart meters are more than energy monitors, however, in that they allow two-way communication between the meter and the utility at frequent intervals, thereby enabling utilities and consumers to make appropriate real-time adjustments to reduce costs and increase efficiency. Conservation voltage reduction (CVR) includes technologies that provide lower voltages to save energy (which can happen only when smart meters provide an adequate picture of the grid).[6] And with the use of outage management systems (OMS), the grid can alert utilities of outages, as opposed to waiting for customers to call.[7] This can be particularly helpful during severe storms, as Jeff St. John of Greentech Media states:

> We've already seen reports of successful implementation of these AMI-assisted outage restorations in the wake of Hurricane Sandy and other weather events. After several years of effort, these systems are also becoming reliable enough to give line crews the ability to fix as-yet-unreported outages such as those that happen when people are asleep or away from home.[8]

### Improved planning

Finally, predictive analytics derived from big data can serve as an important tool in determining the energy planning necessary to power a city. Over shorter time horizons, predictive analytics can help utilities prepare for storms down to the meter level. Similarly, the ability to use data to gain a better picture of solar and distributed generation sources can help cities meet renewable goals or plan future projects. For example, an accurate assessment of hourly demand is needed on solar projects to predict the cost-benefit ratio for photovoltaic and concentrated solar power. The use of big data can aid in determining demand curves—as well as the bottom line—for corporations and municipalities, thereby increasing reliability and reducing costs.

The smart grid provides both breadth and depth in terms of the data required for predictive analytics. Increased consumer knowledge and behavioral change, supplemented by better natural resource allocation, can ensure the best infrastructure for residents, lower energy costs, and conserve natural resources.

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6. Jeff St. John, "Big Data on the Smart Grid: 2013 in Review and 2014 Outlook," *Greentechgrid,* December 16, 2013, http://www.greentechmedia.com/articles/read/Big-Datas-5-Big-Steps-to-Smart-Grid-Growth-in-2014.
7. Ibid.
8. Ibid.

## Chicago's big data energy initiatives

The City of Chicago has recognized that a more efficient city is a more competitive city and is taking advantage of the opportunity to apply "smart" technology and big data to the energy sector.

### Setting goals through legislation and city initiatives

In May 2013 Illinois enacted the Energy Infrastructure and Modernization Act, known informally as the "smart-grid bill," which will roll out over the next 10 years. As a result of this policy, ComEd, one of Illinois's major electricity utilities, will invest $2.6 billion in smart-grid implementation in Chicago and will install smart meters in homes (on the south side in 2014 and the north side in 2016), with the goal of having a smart meter in each of the city's 1.3 million homes or businesses by 2018 (the law mandates a total of four million smart meters throughout the state).[9] The legislation also requires a 20 percent reduction in service outages, the elimination of estimated billing, and a reduction of energy theft.

Other legislation also seeks to increase energy efficiency in Chicago. On September 11, 2013, the Chicago City Council voted to approve the Building Energy Use Benchmarking Ordinance as proposed by Mayor Rahm Emanuel.[10] This ordinance requires owners of large commercial and residential buildings to measure and report their energy use to the city, after which the city will publicly disclose the collected data. The ordinance will be implemented over several years beginning in 2014 for all buildings over 250,000 square feet and will ultimately apply to all buildings over 50,000 square feet.[11] Building owners will be required to track and verify the annual energy consumption of their buildings using a free web-based tool provided by the Environmental Protection Agency. The public availability of this data should help motivate building owners to implement energy-efficiency upgrades for the purposes of saving money and making their properties more attractive to tenants and investors. According to Cliff Majersek, executive director of the nonprofit Institute for Market Transformation in Washington, DC, "This law will drive transparency and awareness of energy use in the city's buildings and accelerate the market for energy efficiency, which will create local jobs."[12]

In addition to the Building Energy Use Benchmarking Ordinance, Chicago has implemented several other initiatives demonstrating its commitment to energy efficiency. For example, the city has committed to improving the transparency of energy efficiency and energy use (among other goals) through the program Sustainable Chicago 2015, which sets 24 goals across seven sustainable categories, including economic development and job creation; energy efficiency and clean energy; transportation options; water and wastewater, parks, open spaces, and healthy food; waste and recycling; and climate change.[13] Also, through the Better Buildings Challenge, a collaboration with the Department of Energy, the city is obligated to reduce energy use by 20 percent across 24 million square feet of public and private buildings.[14]

### Targeting areas for improvement in energy efficiency

In order to achieve these goals, the city needs to know where to focus its efforts to make the greatest improvements in energy efficiency. Big data is helping the city do just that. The City of Chicago worked with Accenture to gather information from the smart grid and understand what all this data means. Accenture created one of the most detailed databases of energy usage in the United States, tracking both electricity and natural gas usage and combining it with building characteristics to present an accurate assessment of the city's best opportunities to increase energy efficiency.[15] The database is now used by the Chicago Innovation Delivery Team, which is sponsored by Bloomberg Philanthropies and tasked with significantly reducing

9. City of Chicago, "Mayor Emanuel, GE, Silver Spring Networks, and ComEd Announce Implementation of a Smart Grid to Begin," Press Release, July 9, 2013, http://www.cityofchicago.org/city/en/depts/mayor/press_room/press_releases/2013/july_2013/mayor_emanuel_gesilverspringnetworksandcomedannounceimplementati.html.
10. Institute for Market Transformation, "Chicago Passes Energy Benchmarking Ordinance," September 11, 2013, http://www.imt.org/news/the-current/chicago-passes-energy-benchmarking-ordinance.
11. Ibid.
12. Ibid.
13. City of Chicago, "Sustainable Chicago 2015," http://www.cityofchicago.org/city/en/progs/env/sustainable_chicago2015.html.
14. Ben Lack, "Chicago Joins the Better Buildings Challenge," *The Daily Energy Report,* June 14, 2012, http://www.dailyenergyreport.com/chicago-joins-the-better-buildings-challenge/.
15. Accenture, "City of Chicago: Accelerating Energy-Efficiency Retrofits," 2012, http://www.accenture.com/us-en/Pages/success-acn-helps-chicago-accelerate-building-energy-efficiency-retrofits.aspx.

energy use in predetermined zones throughout the city.[16] Therefore, Chicago now has the tools to specifically target areas of the city that could benefit from retrofitting and to track achieved energy savings.

### Giving consumers access to big data

The first and most basic opportunity for the use of big data is to better understand, predict, and ultimately change consumption and delivery/supply patterns. The extent to which residents use infrastructure and consume commodities is not always readily apparent—they do not easily see and cannot easily know in real time how much energy or water is being used, for example. However, research has shown that simply providing such information to consumers can prompt them to make better choices, in this case about energy consumption. So the challenge is to acquire and disseminate this information in an accessible and transparent manner. Several companies are already developing the tools to do just that.

For example, the data generated by smart meters, which are being installed by ComEd across the city, will provide a tool to analyze and optimize energy usage. Smart meters allow consumers to see their usage in real time, empowering them to make decisions that could reduce their energy costs. For example, if there are dynamic pricing options in place, meaning that the price of electricity changes depending on overall demand or time of day, then consumers with access to real-time data can make decisions to immediately use less energy and thus lower their costs, if they choose. Moreover, merely showing customers how much energy they use on a relative basis can lead to a decrease in consumption. In 2009 ComEd began issuing home energy reports, an analysis of how customers' individual energy usage compares to that of their neighbors, and almost immediately saw a 2 percent decrease in electricity use. According to ComEd, neighbor comparisons are more effective than telling people that they can save the environment or even money.[17] Home automation technology also provides an avenue for savings. For example, the company Nest, which was recently acquired by Google, provides smart or "learning" thermostats that monitor heating and cooling patterns in individuals' homes and can adjust its settings throughout the day to save energy.

16. City of Chicago, "Mayor Emanuel Announces That Bloomberg Philanthropies Will Fund Innovation Delivery Team," Press Release, July 14, 2011, http://www.cityofchicago.org/city/en/depts/mayor/press_room/press_releases/2011/july_2011/mayor_emanuel_announcesthatbloombergphilanthropieswillfundinnova.html.

17. ComEd, "Home Electricity Report Pilot Program Performance Update (August 2009 – January 2010)," February 2010, accessed May 13, 2014, http://ilsagfiles.org/SAG_files/Meeting_Materials/2010/February%2023,%202010%20Meeting/ComEd_Home_Energy_Report_Pilot_Program.pdf.



### Promoting collaboration

The City of Chicago has also taken steps to encourage collaboration among various parties to achieve its energy goals, including the private, governmental, and nonprofit sectors. The city has already seen success in convening these various parties and their stakeholders. For example, the Illinois Institute of Technology is home to the Illinois Smart Grid Regional Innovation Cluster, a group of innovation and economic development institutions working to develop a smart-grid technology cluster in Illinois.

Similarly, innovative groups such as the Energy Foundry provide important incubator services to energy entrepreneurs in Chicago. With initial funding provided by ComEd and Ameren, Energy Foundry was established as part of the Illinois Energy Infrastructure Modernization Act and is a $22.5 million venture fund created to invest in Illinois energy and clean-tech companies that could utilize the state's smart grid.

## Challenges for big data in the energy sector

The following sections address some of the challenges in leveraging and implementing big data, looking most closely at the cost-effectiveness of the undertaking.

### Cost

Even if utilities and other stakeholders agree that the smart grid and big data are great ideas, they need to know how they are expected to pay for such massive upgrades and if these upgrades are worth the investment. As discussed, Illinois enacted the Energy Infrastructure and Modernization Act in 2013, which will result in $2.6 billion in consumer rate hikes over the next 10 years. This bill was negotiated largely between the state and ComEd. In exchange for the rate increase, ComEd has pledged to digitize the electricity grid, claiming that the upgrade in operational infrastructure will result in long-term consumer savings.

In this way, the law allows for the state's utilities to partially pass on investment costs to consumers for smart infrastructure via grid modernization and various energy-efficiency projects. The state's utilities, including proponents of the bill such as Ameren and Exelon, saw the bill as a way to sustainably and competitively allow utilities to invest in the long-term viability of Illinois's electricity infrastructure. The bill's supporters argued further that the modernization will create jobs, reduce power outages, and give consumers more say over their energy consumption, the latter point being achieved in part by promoting the use of in-home devices that let consumers control more aspects of their electricity usage. The critics argued that the bill would be more costly for consumers without a tangible benefit. Opponents of the bill, including Illinois Governor Pat Quinn, Illinois Attorney General Lisa Madigan, and the Illinois Commerce Commission, felt that the bill was a burden for consumers and a giveaway to the utilities.[18]

The bill's detractors also questioned the claims of savings and efficiency, arguing that the actual benefits will pale in comparison to the massive scale of the investment. While the bill's supporters ultimately won the argument with passage of the legislation, the cost-benefit issue continues to be plumbed, and there are now new means to evaluate the benefits of the smart-grid upgrade.

In 2011 the Environmental Defense Fund (EDF) introduced the country's first "smart-grid scorecard" to evaluate the efficacy of California's smart-grid investments. Specifically, EDF created a framework to assess whether the smart grid allows consumers to save money and energy and enables the integration of smaller renewable energy sources into the centralized power grid.[19] In 2013 EDF collaborated with the Citizens Utility Board in Illinois to implement similar tracking mechanisms and metrics for Illinois' smart grid.[20] ComEd will have to track metrics for this initiative in addition to those already required by the smart-grid act. The metrics include actual consumer benefits and participation such as the extent to and speed with which consumers can access their data and tap into renewable energy sources.[21]

While reporting on these new metrics is yet to come, some research already shows the cost savings that can be achieved with smart grid upgrades. For example, it appears that ComEd has seen and will continue to see significant savings from the installation of smart meters. A 2011 report that evaluated ComEd's AMI implementation found that the benefits will greatly outweigh the costs of the program.[22] Although ComEd would invest $996 million in new capital and incur $665 million in operational costs, the report found that benefits over the 20-year evaluation period exceed the costs by a factor of almost three.

### Data compatibility and skills gap

The ability of utilities to leverage or even keep pace with the rapid technological advances and costs associated with implementing and utilizing big data is a major challenge. Beyond this, another major challenge to fully leveraging big data is integrating data from various sources on the grid. Erich Gunther, chairman and chief technology officer of EnerNex, sums up the challenges of data integration, explaining that data is "distributed over many different systems; there are no processes within an organization to keep them synchronized or up to date, … and we don't even have any standards in place in the industry."[23]

In addition to these challenges, utilities face a shortage of qualified workers to address them. For example, according to Oracle's survey "Utilities and Big Data," 62 percent of utilities say they have a skills gap surrounding smart-grid data analytics, and only 17 percent of respondent utilities feel completely ready to digest the amount of

18. Michael Piskur, "Understanding Illinois' Smart Grid and Distributed Generation," Progress Illinois, November 17, 2011, http://www.progressillinois.com/posts/content/2011/11/16/understanding-illinois-smart-grid-and-distributed-generation.
19. Environmental Defense Fund, "First-of-its-kind Smart Grid Scorecard Will Help Ensure Utility Plans Deliver Promised Benefits," News Release, June 6, 2011, http://www.edf.org/news/first-its-kind-smart-grid-scorecard-will-help-ensure-utility-plans-deliver-promised-benefits.
20. "New smart grid metrics to track customer benefits for Illinois utilities," Metering.com, April 9, 2013, http://www.metering.com/new-smart-grid-metrics-to-track-customer-benefits-for-illinois-utilities/.
21. Environmental Defense Fund, "Pioneering smart grid energy metrics will help measure customer benefits in Illinois," April 3, 2013, http://www.edf.org/news/pioneering-smart-grid-energy-metrics-will-help-measure-customer-benefits-illinois.
22. Andrew Trump and Kolten Sarver, "Advanced Metering Infrastructure (AMI) Evaluation Final Report," July 2011, https://www.sgiclearinghouse.org/CostBenefit?q=node/4566&lb=1.
23. Jeff St. John, "Big Data on the Smart Grid."

data they are consuming.[24] Likewise, the cost of implementing smart meters and other technology, in addition to training employees in new methods, remains a real challenge. While the cost-reduction benefits for utilities are conceptually straightforward, they must be proven in successful implementation and practice. Oracle's study finds that "the average utility with more than one million customers will invest approximately $180 million in the smart grid and smart metering over the next five years."[25]

### Privacy

While the benefits of big data—i.e., providing a more extensive understanding of electricity consumption and production—are pretty clear, consumers have understandable concerns about privacy. Who has access to the data, and how is it being used? A great deal of user information is already collected and reported to the utilities for billing purposes, and a variety of models have been implemented to ease privacy concerns. For example, aggregate data is typically analyzed and presented back to all users, meaning that individual data becomes anonymous and is shown simply on a relative basis to the average.

But even with such safeguards in place, there is no doubt that many consumers will recoil at certain aspects of the smart grid and the use of big data. For example, it is easy to imagine that many consumers would not be comfortable with their utility controlling certain noncritical, in-home systems or appliances via the implementation of a demand response mechanism, even if it meant lower energy bills.

### Data security

In today's information economy, big data is the new reality. But while it produces tremendous benefits, it also brings with it the risk of significant security breaches. Personal information is collected, synthesized, and analyzed via online portals promising safeguards from hackers. However, intensive campaigns to corrupt vast collections of data are affecting even large US systems.

24. "Utilities and Big Data: Accelerating the Drive to Value," Oracle, July 23, 2013, http://www.oracle.com/us/industries/utilities/oracle-utilities-2013-report-1977336.pdf.
25. Ibid.



For example, in August of 2013 the Department of Energy notified its employees that more than 14,000 names and Social Security numbers of current and former agency employees had been compromised.[26] This was the second breach of data security that year. While the Department of Energy is said to be working with law enforcement in order to investigate the breach, it is likely that the hackers responsible will use the information collected to target other systems.

As public scrutiny increases and technological infrastructure changes, laws and policies struggle to keep up with the ever-evolving privacy sector. Big data involves big risk. Protecting data systems mandates vigilance and superior technologies not yet perfected.

## The future of big data and energy

The societal implications of applying big data to the development of energy infrastructure and usage are dramatic and may extend to the environment and energy markets as well. Data sets are being produced not just by the smart grid or meters. Sensors are also increasingly providing better weather prediction both at the micro and macro levels, which creates better data from which to predict energy demand. And phones are producing voluminous location data (for example, using your phone's GPS, your house can know when you are home or away and adjust its temperature accordingly). The effectiveness of the power grid depends largely on the ability to accurately match predicted demand to available generation, so being able to more reliably predict weather patterns, along with the ability to decrease demand via automated communication between one's phone and home, will be very powerful.

The environmental and societal benefits are significant, especially in areas where generation is either coal- or gas-turbine-focused. One use of big data will be the better integration of renewable energy sources into the overall power grid.

In addition, big data–driven technology provides significant economic opportunities for both entrepreneurs and large companies alike, creating new markets that can be tapped at both global and hyper-local levels. Finally, reliable, low-cost electricity is a distinct competitive advantage for industries that require significant elec-

26. US Department of Energy, "July 2013 Cyber Incident," Press Release, http://energy.gov/cio/cyber-incident-information/july-2013-cyber-incident.

tricity generation such as data centers and high-tech manufacturing and processing entities, to name a few.

Big data could also have a significant impact on energy markets by lowering the overall volatility and possibly the price (certainly peak pricing) of power in the United States. This is possible and likely if big data leads to a smart grid that can better coordinate consumer demand and power generation.

While there are clearly great opportunities for cities to leverage big data to better serve consumers, the utilities face significant challenges in implementing these plans. As evidenced in this chapter, Chicago has undertaken a number of initiatives to help address the challenges. At an event unveiling a collaboration between GE and ComEd, Mayor Emanuel reaffirmed his commitment to the smart grid, stating:

> Chicago's new smart grid is substantially increasing economic opportunity for the city by adding both manufacturing and professional jobs, opening new offices and facilities, and helping Chicago residents conserve electricity and save money…. A modern, high-tech electric infrastructure is essential for Chicago's global economic competitiveness.[27]

Although Chicago is focused on moving forward with these initiatives, not everyone is convinced they will be successful. Real-time outage and consumption reporting may actually increase the responsibilities of utilities, leading to their resistance. Mel Gehrs of Silver Spring Networks states:

> Smart-grid data is beginning to give us a view of what the customer is actually experiencing, something that we've never seen before…. Now we'll tell you that some utilities are not thrilled to know this because its kind of a two-edged sword, because then you have to go out and fix it if it's bad.[28]

27. City of Chicago, "Mayor Emanuel, GE, Silver Spring Networks, and ComEd Announce Implementation of a Smart Grid to Begin," Press Release, July 9, 2013, http://www.cityofchicago.org/city/en/depts/mayor/press_room/press_releases/2013/july_2013/mayor_emanuel_gesilverspringnetworksandcomedannounceimplementati.html.
28. Jeff McMahon, "Big Data From Smart Grid Tells Utilities More Than They Want To Know," *Forbes,* September 26, 2013, http://www.forbes.com/sites/jeffmcmahon/2013/09/26/big-data-from-smart-grid-tells-utilities-more-than-they-want-to-know/.



Thus, utilities might be quite reluctant to be held to a higher standard of service at the same time that they complain of deteriorating profitability. Moreover, the passage of the smart-grid policy was the subject of much political consternation, as Governor Quinn feared that it gave ComEd too much autonomy without enough oversight by the Illinois Commerce Commission.[29] It is reasonable to fear that politics could derail, or at least slow, a smart grid proliferation. Finally, skeptics doubt how much a massive investment in smart grid technology and the use of big data will actually help consumers or lower prices.[30] Nonetheless, there appear to be clear opportunities for the City of Chicago to benefit from big data and smart-grid solutions—opportunities that the current administration is keen to seize.

29. Bridget O'Shea and James O'Shea, "A Smart Power Grid Begins With a Promise For the Future," *The New York Times,* January 21, 2012, http://www.nytimes.com/2012/01/22/us/comeds-smart-grid-begins-with-a-promise-for-the-future.html?pagewanted=all&_r=0.
30. Ibid.

Chapter 3

# Big Data and Transportation

In cities around the world, transportation, controlled either by private companies or provided by the public sector, serves as the underlying means by which the functioning urban organism operates. When a population's mobility—as well as the movement of goods and services—is hindered, a city's day-to-day life, growth, and future are stifled. Providing efficient movement of people and goods locally, nationally, and internationally is critical to a vibrant and thriving city.

Big data provides a better means of viewing, analyzing, and discovering potential solutions to problems in the transportation system than ever before. Chicago's historical interest in the use of emerging technologies bodes well for addressing the complexities and challenges presented by a modern transportation system. The mayor's recent commitment to open data is evident in the transportation sector, as Chicago has actively engaged in transportation solutions using data analysis and has officially listed over 90 transportation-related data sets as open and available to the public.

## Chicago's big data transportation initiatives

Use of big data has dual advantages. It allows the city to provide better service through improved planning and more efficient traffic and public transportation solutions, and it allows businesses and the public to access real-time information on vehicular traffic and bus and train schedules that helps them better plan their daily schedules. Two examples of leveraging this big data—traffic control and public transportation via buses and trains—provide high-quality case studies of what is possible.

### Providing detailed travel information via the Chicago Traffic Tracker

Chicago's new data portal has opened up opportunities to use big data to enhance public information and the efficiency of transportation. In addition to providing access to "static" information such as roadway maps and allowing the purchase of public transportation passes and payment of traffic-related fees, the data portal provides pattern-related information such as pedway and bicycle routes, bus turnaround lanes, and ridership and daily traffic counts. Chicago's data portal also provides real-time information that can be used to improve future planning and offer better solutions to transportation challenges.

A primary example of this is the Chicago Traffic Tracker, which provides information on traffic congestion and allows for enhanced transportation decision making. This portion of the website, currently running in beta, provides real-time traffic conditions on the arterial streets, average daily traffic (ADT) volumes, traffic signal locations, pedestrian counts, and automated red-light enforcement program intersections throughout the city. The data set contains the historical estimated congestion for the 29 traffic regions. The tracker continuously monitors and analyzes GPS traces received from Chicago Transit Authority (CTA) buses, monitoring congestion every 10 minutes for each traffic segment and zone.

At present, due to the massive complexity of the data system and the infrequent (10 minute) collection of data points, the usefulness of this data is marginal beyond a simple visualization of traffic patterns. Planned enhancements to the site include travel times, live images from traffic cameras, and planned and unplanned roadway incidents.[31] This increased granularity and near real-time data feed could benefit many groups in the city. Residents could make more informed decisions on point-to-point travel times and flex their schedules to avoid being caught in congestion. Businesses could plan more efficient logistics, minimizing fuel consumption and further reducing congestion. City planners could make more fact-based decisions on future capacity expansions and high-value investments to alleviate bottlenecks.

### Improving service via the Train and Bus Tracker

The CTA runs the nation's second-largest transit system, with around 1.6 million trips taken each day. CTA also gathers lots of data. They know where buses and trains are in real time and how many people get on and off at each bus stop with Train and Bus Tracker Programs.

Through these CTA tracking programs, passengers who want to receive estimated arrival times for trains at all 144 rail stations across

31. See http://www.chicagotraffictracker.com/.

CTA's eight rail lines can access the information online. Similarly, for CTA buses, passengers can enter a stop and view arrival times in one-minute increments.

Within the CTA Train Tracker program, estimated arrival times are generated through a combination of scheduling information and data collected by software. The program monitors a signaling system, which indicates when a portion of track is occupied by a train. The CTA Train Tracker calculates estimated arrival times by first measuring how long it takes a train to travel a portion of track and then averaging the times of the last five trains to move across a portion of track. Arrival times of approaching trains are provided within a 15-minute time frame for the selected station, with results refreshing approximately every 20 to 30 seconds. Passengers can view train arrival times by platform or route if the station is served by multiple rail lines or by time of the next arriving train. Customer alerts are also integrated into the CTA Train Tracker website and will notify riders of any planned events affecting rail service. Train arrival information also is displayed at some rail stations using existing electronic signs, demonstrating how the same data sets can enhance the system in multiple ways.

Similarly, the CTA Bus Tracker uses GPS devices to report bus location data to central servers. Through a real-time application, the tracker can then show buses on a map to online users and provide estimated times of arrival at each bus stop.

As in cities around the world, much of Chicago's resident population utilizes public transportation on a daily basis. This new use of big data has helped CTA improve the reliability and quality of public transportation. Notably, both programs were implemented with low additional expenditures. This illustrates that the use of data and technology can provide new avenues for system improvements that enhance a community's experience even when a city may be experiencing economic pressure.

### Reducing bus overcrowding and improving planning

A final example related to both traffic patterns and public transportation is Chicago's use of big data simulation to improve transit planning and reduce bus crowding. The project began as a part of the 2013 Data Science for Social Good fellowship at the University of Chicago, in partnership with the CTA. The fellowship has partnered with the city in developing modeling and simulation tools to predict the frequency of problems and create possible solutions.

During recent years the CTA has made a concerted effort to decrease the crowding on public transportation to increase comfort, health, and safety. To this end, it has actively collected information on the number of passengers riding a specific bus, the times at which passengers board buses at specific stops, and the delay times on different routes, among other information. These data are analyzed for the purpose of modifying schedules and routes for the coming months. The 2013 partnership further enhanced this effort through big data collection and analysis. The project is a good example of how Chicago partners to utilize big data, since data analysis goes directly to understanding bus overcrowding.

When considering scheduling, the CTA must understand passenger demand for each route. This allows planners to provide an adequate number of buses. Once buses are deployed, tracking is essential in order to determine whether there is passenger crowding at stops and on buses along the route. Even if enough buses are running to accommodate passenger demand, a large gap between vehicles can cause crowding. If buses are not spaced evenly along the route, certain buses will be crowded while others will be underutilized. If a bus falls behind schedule—due to traffic, red lights, or more riders than usual—the stops ahead accumulate more riders than they usually would between buses. With more riders on board, the likelihood of someone wanting to get out at each stop increases. The bus stops more frequently and falls further behind, creating a negative feedback loop. Eventually, an on-time bus following behind catches up, creating a "bunch."

Previously, the CTA counted how many passengers got on buses through the fare collection process. Fare collection provides data on how many people are getting on the bus, but it does not provide information on where people are getting off and therefore on how many riders are actually on each bus ("bus load") at a given point along the route. While the total ridership numbers are critical for planning bus service, they did not provide insight into route crowding.

A data-based solution to bus overcrowding seems intuitive. If schedulers can run more buses on a route by reallocating them from another route, this prevents the situation described above. Reducing gaps between buses becomes a critical goal, which may involve field supervisors making on-the-fly changes once buses are on the road. To do this, data on passenger demand—independent of bus frequency—is required to examine the flow of a route, or the total number of people riding by a stop during a particular time period.

Feeds for real-time location data—now being provided by CTA-installed sensors, GPS, and passenger counters, are allowing this to happen. These technologies not only enable near real-time decision making, but generate a massive volume of historical data that can be analyzed to detect patterns for future planning as well.

Through the use of extended GPS technology, the buses themselves do the counting. Infrared beams positioned at both the front and rear doors record an "on" and an "off" when someone boards and debarks. Using GPS, these "ons" and "offs" are tied to each stop along the route, with the data saved to a hard drive on the bus and uploaded to a central server each night once the bus returns to the garage. Tracking the number of passengers getting on and off allows for an estimate of the number of people on the bus as it leaves each stop. Since the CTA now does this for every stop on every route in the system, it can also identify the busiest stop in the route—the area of "peak flow." The passenger flow at this "maximum load point" is the main determinant of how many buses must be run to achieve a certain crowding level, or bus load.

This project provides a good illustration of methods that can be employed by a city with a practical eye toward additional monetary investment. The trade-off between reducing crowding and spending additional funds is apparent, and Chicago has been able to bridge that gap. Through adoption of updated technologies, a willingness to consider new measurements, and a partnership to gain knowledge, Chicago has encouraged the successful use of big data methods for public transit.

## Challenges for big data in the transportation sector

The infrastructure and the technology behind urban transportation systems, including Chicago's, are complex. This complexity creates numerous challenges. First is capacity. Only so many vehicles, people or items can be moved at one time in a limited infrastructure. Capacity is limited by the amount of space, the degree of integration among systems, and speed available. From a data perspective, it can be difficult to collect all the data in the moving parts of a given transportation system. Finally, cost can be a challenge. Who will pay for the additional infrastructure needed to create efficiencies within a system, let alone integrating systems? What will it take to cover the costs required to actually change the behavior of drivers, passengers, or public transportation customers to improve transportation flow?

While these challenges can be difficult to overcome, they also offer opportunities. Data on the regular patterns of movement inherent in the current systems can be analyzed to provide insight on how current patterns and behaviors might be changed to create greater efficiencies in the overall system. The more data that can be captured on the regular patterns of movement, the more intelligence there will be on which to base new proposals. The "bigger" this data the better, providing cities the potential to re-engineer the human experience to save time, reduce costs, and be more sustainable. The behavioral nature of commuter patterns becomes even more relevant through big data analysis and allows for new ways of looking at these challenges.

## The future of big data and transportation

Leveraging big data in transportation could be a game changer for cities. Studies have found that, on average, roughly 30 percent of cars in urban traffic are searching for parking. Big data can help address this. Google's driverless cars, powered by leveraging and quickly analyzing massive amounts of data, have logged over 700,000 miles accident free. Using big data to create more efficient public transportation systems increases the likelihood of usage and could significantly reduce carbon emissions from passenger cars and trucks. The future is bright for big data in transportation.

The future is also bright for big data and transportation in Chicago. While Chicago's current transportation initiatives are data-focused, they have also been retrospective in nature. The 2013 Data Science for Social Good Fellowship proposed to turn public-sector transport scheduling into a prospective exercise through statistical modeling and simulation. The vast quantities of vehicle location and passenger count data could predict crowding along a bus route, for example, before it develops. Collection of bus ridership and service data would allow the CTA to forecast how adding or removing service on a route might affect its crowding levels. These statistical models could help CTA make more proactive service decisions than is done today.

The Chicago case study illustrates a political will among the city's administration to not only invest in technology but also pilot new ways of doing things. The city also allowed for training and technology for bus drivers and traffic control officers. Ultimately, the trust in allowing large data information to drive technology for seamless connectivity with applications and to complete the infor-

mation loop provides a successful enhancement to the urban transportation system.

Additional success factors include a willingness to invest in independent expertise, the ability to collaborate with various agencies and external partners, and the development of a specific internal knowledge base.

Remote tracking technologies made available in the past decade have made the gathering of relevant transportation data possible. Cities looking for examples of best practices can draw from this use. Analyzing data patterns that look to vehicle and user behavior can provide opportunities for increased efficiency.

## Box 2– Big data transportation initiatives in Ireland and China

While Chicago has leveraged big data to create several helpful applications for residents and businesses, it is by no means alone in taking action. In looking briefly at examples from other cities, we uncover similar programs. For instance, Dublin, Ireland, employed an Intelligent Transport System that generates, collects, and analyses big data to improve the reliability and punctuality of its transportation service. Dublin, with a population of 1.5 million, is a sprawling city with issues of traffic congestion between the city center and surrounding suburbs. Dublin bus service has a fleet of 1,100 buses carrying 500,000 passengers daily over a network of 220 routes. Dublin equipped each bus with a data-capable radio device that broadcasts GPS information by the minute, with a control center then collating this information to give passengers real-time data on expected bus arrival and schedule interruptions. In addition, the bus information system communicates with roadside traffic light control units so delayed buses can be given priority. The availability of real-time data and improved reliability reduce passenger uncertainty, encourage the use of public transportation, and help relieve the city's traffic congestion problem.

The taxi industry across China supplies a significant amount of public transportation in cities. Yet growing urban populations and lagging transportation management has led to traffic bottlenecks. To combat this challenge, the Ministry of Transport launched a national initiative to develop an urban taxi management platform designed to improve the timeliness and security of public transportation and deliver better taxi service to citizens. A new platform was piloted in Beijing, Kunming, Chongqig, and Tianjin in late 2013. The ministry, along with its partners, now have the capacity to analyze 6 to 36 billion data records annually in real-time. Their cutting-edge technology has focused on the upgrade of industrial management and the elimination of traffic bottlenecks. The result of this project and similar activity has allowed urban transportation management organizations to quickly understand traffic situations, accurately analyze passenger flow and taxi operations, and get real-time insights for making fact-based decisions. Through the use of new operational models in the taxi industry, China's four cities are improving the decision-making efficiency of the management department and significantly elevating service across the entire industry. The models are flexible enough to be used for the operational analysis of bus and rail transit, analysis of capacity and pricing subsidies for public transportation, and labor analysis.

Sources: Latamore 2013; Paul 2013.

Chapter 4

# Big Data and Education

Big data has the potential to transform education, and this is particularly true in Chicago. Harnessing data mining and applied analytics, big data in education can greatly increase the quality of instruction, monitoring, evaluation, and accountability. At its core, big data leverages vast amounts of education data about students, educators, schools, and communities to inform new approaches to learning and education management.

## Big data in Chicago Public Schools

Chicago Public Schools (CPS) is often cited as one of the country's worst urban school districts. Across a number of indicators—from high school graduation rates to test scores—CPS has historically failed to provide the majority of Chicago's youth with a quality education. Despite the fact that education reform has been a top priority for the city for decades, CPS has been slow to improve. However, big data is changing this. For example, in 2003 the CPS high school graduation rate was 44 percent, and today that number has grown to 65.4 percent. Furthermore, current CPS high school freshman are on track for an 82 percent graduation rate.[32] By collecting and analyzing linked data sets, researchers can develop a clearer understanding of what drives student performance and test whether new initiatives are successful at addressing gaps in the educational system.

Until the last few years Chicago teachers relied on quarterly test scores to understand student performance. Now, through big data, teachers can not only understand student performance, but can analyze every detail of student learning in microscopic detail with the goal to determine what techniques are most effective for each student. Furthermore, the data can help the teacher predict student performance and identify when students deviate from anticipated outcomes.

For administrators, big data can provide a 30,000-foot view of progress at all levels of the system. Big data allows teachers and schools to be followed and tracked over time. As this is accomplished, administrators gain a much better understanding of how key education factors intersect and affect each other. They also gain an understanding of the effects of policies, programs, and changes in organization because they actually see what's happening over time across different arenas.

> ***"Everybody in the country knows about what is going on in Chicago in terms of data, the ninth grade on-track indicator, FAFSA [Free Application for Federal Student Aid] completion, and more. The Chicago Consortium of School Research is the gold standard of school research."***
>
> *—Gregory M. Darnieder, Senior Advisor to the Secretary on the College Access Initiative at the US Department of Education, April 25, 2014*

An unfortunate feature of 20th century urban education was a fragmented data structure. Preschool data remained in preschools. Elementary data remained in elementary schools. High school data remained in high schools. This fragmentation meant system-wide strategic goals were very difficult to meet. Data mining and applied analytics—big data—can integrate all of these formerly disparate systems, allowing administrators to analyze and mine the data, collected in real-time, and see relevant patterns.

CPS is accomplishing these improvements through partnerships with academia, business, and other organizations. One such partnership is with the University of Chicago Consortium on Chicago School Research (CCSR), a leading institution in big data and education. For years, CCSR has been working to improve CPS K-12 education using big data. They are ahead of the curve because they are able to employ massive longitudinal data and linked data sets going back to 1990. CCSR has a unique ability to follow kids over time, assessing many different aspects of what happens to them in and out of school and gaining an understanding of how these situations interconnect.

32. City of Chicago, "Mayor Emanuel Announces Chicago Public High Schools on Track to 82 Percent Graduation Rate," Mayor's Press Release, April 24, 2014, http://www.cityofchicago.org/city/en/depts/mayor/press_room/press_releases/2014/apr/mayor-emanuel-announces-chicago-public-high-schools-on-track-to-.html.

## Increasing high school graduation rates

CCSR has published a number of groundbreaking studies that provide unprecedented insight into the drivers of student achievement. One landmark 2005 study entitled "The On-Track Indicator as a Predictor of High School Graduation" argues that freshman year grades are a much stronger predictor of high school graduation than other factors such as eighth grade test scores or students' background characteristics.[33]

Through extensive research, CCSR determined that freshmen are "on-track" to graduate from high school if they earn at least five full course credits by the end of ninth grade to get promoted to tenth grade and fail no more than one semester of a core subject (English, math, science, or social studies).[34]

In the 2005 study, CCSR used linked data sets to compare freshmen year grades, eighth grade test scores, and background characteristics for over 20,000 CPS students from across Chicago. The resulting analysis showed that fully 81 percent of students who were on track at the end of freshman year graduated from high school in four years. However, only 22 percent of the off-track students graduated in four years.[35]

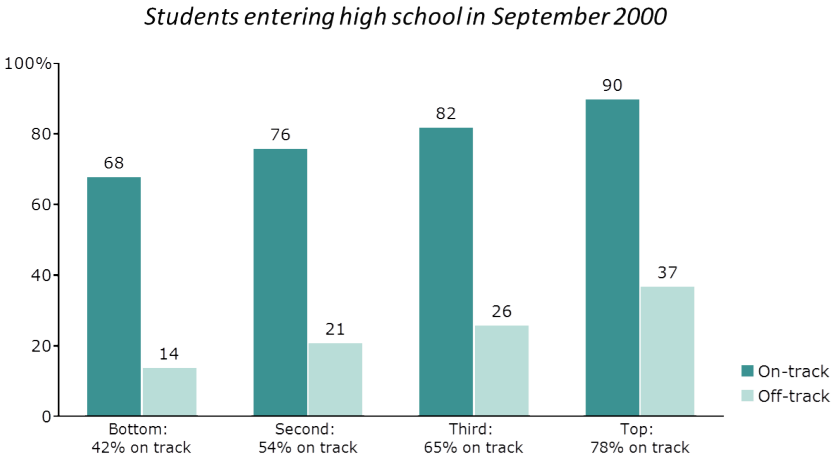
Further, this study demonstrated that being "on track" is a stronger predictor than test scores. As figure 7 shows, only 37 percent of freshmen who scored in the top quartile on the eighth grade Iowa Test of Basic Skills (ITBS) but were off-track according to CCSR's indicator went on to graduate from high school in four years. Conversely, 68 percent of students who scored in the bottom quartile on the eighth grade ITBS but were on-track according to CCSR's indicator went on to graduate in four years.[36]

CCSR also analyzed the relationship between high school graduation rates and both race/ethnicity and economic background. Its findings were that "the on-track indicator is a better predictor of high school graduation than a student's race/ethnicity, elementary achievement, or economic background."[37]

33. Elaine Marie Allensworth and John Q. Easton, *The On-TrackIndicator As a Predictor of High School Graduation,* The University of Chicago Consortium on Chicago School Research, June 2005.
34. Ibid.
35. Ibid.
36. Ibid.
37. Ibid.



**Figure 7– Four-year graduation rates by on-track status after freshman year and incoming reading and mathematics achievement**




Source: Elaine Marie Allensworth and John Q. Easton, "The On-Track Indicator As a Predictor of High School Graduation," The University of Chicago Consortium on Chicago School Research, June 2005, https://ccsr.uchicago.edu/sites/default/files/publications/p78.pdf.

CCSR's insights about what drives high school graduation rates is a critical finding for the education field because it enables policymakers, school leaders, and educators to further refine their focus and allocate resources and time more effectively to drive student performance. As the report noted, "by using the on-track indicator, schools can focus their resources on individual students who are at highest risk for failure, rather than simply focusing on their backgrounds."[38]

CCSR's pioneering work in big data and education has already achieved success in impacting student outcomes. CPS graduation rates have improved dramatically from less than 50 percent to 65.4 percent or 19,905 students, and CCSR predicts that this rate will increase over the next few years. Part of this improvement has come from being able to follow kids over time and better understand what really matters. CCSR's Elaine Allensworth explains:

> There was a lot of research out that said whether kids graduate is affected by all these different things—'what happens outside of school [and] all throughout their educational

38. Ibid.

### Box 3 – CCSR data sources

- Base data from CPS's Impact System (includes information such as name, age, address, race, gender, schools attended, and grade level)
- Additional CPS student information (includes grades, test scores, teachers, class composition, disciplinary information, and graduation outcomes)
- National student clearinghouse data: college outcomes
- Teacher and school administrator background files
- Census data, including socioeconomic data by city block (e.g., Chicago has 10,000 block groups)
- Police department/crime statistics by neighborhood
- Arrest records inside and outside of school
- Employment status and earnings information
- In the future, health information

Source: Elaine Allensworth.

history' and 'it's hard to know who's going to drop out'—so it really was this unmanageable problem. However, by following kids over time and really looking at where are they dropping off and what factors were influencing this, we discovered that the ninth grade year was a critical year for intervention. We also could then bring in this other data to show what factors are related to graduation and where to focus efforts to reduce drop-out rates.

## Improving school safety

CCSR also uses big data in CPS to link data to public safety issues. CCSR did a city-wide study on safety in Chicago Public Schools (subject to continuous evaluation and examination), including grades six through 12, in which it examined the factors that influence whether kids feel safe in school. Through vast amounts of linked data they were able to tie critical issues together. They examined poverty and crime in students' neighborhoods, community surveys, and reports of the community social resources to understand how these factors are interrelated, along with achievement levels of the schools, teacher reports of crime and disruption, and the use of suspensions and other disciplinary procedures.

The picture that emerged was clear: poverty and crime in kids' neighborhoods are strongly related to the level of safety in schools and the degree of academic problems. But, another factor emerged—the achievement level of the students affects the safety of the school more so than the neighborhood of the school. Kids coming from the high-poverty or high-crime neighborhoods are more likely to have low levels of achievement, so the degree to which schools are concentrating kids with low achievement or high achievement together is a critical factor.

Suspension practices are another factor in school safety. While many schools regularly suspend students for behavioral problems, data show that this is not the most effective way to keep schools safe. In fact, suspending kids more actually results in lower levels of safety. A study is currently under way to understand why schools use suspension and what happens when suspension practices are changed. Including police data in the study will allow deeper analysis.

Through this novel application of big data in education, policy decisions are being made in new ways. Based on the CCSR work, CPS changed their code of conduct to try to discourage long suspensions and the use of suspensions. In the future they are going to further narrow their code of conduct, and they're going to cite CCSR research to provide an objective picture of issues.

## Combating violence

In an earlier initiative in 2010, CPS worked with major consulting firms to create new, data-driven models to combat violence among school-aged students. The goal was to create a safe environment for CPS students to excel academically and reduce the likelihood they will be involved in violence. Analysis of linked data sets showed:

- Twenty-five percent of CPS high schools experienced 80 percent of the total homicide and aggravated battery incidents.
- Underperforming schools have up to 15 percent fewer counselors, psychologists, and social workers per student.
- Underperforming schools also reported less participation in parent-teacher conferences.

In order to identify students at risk of becoming victims of violence, CPS analyzed data by type of school (neighborhood, selective enrollment, magnet, military, career academy, charter, alternative), gender, race, academic performance, attendance, behavior, special education, and living conditions (homeless/transient).

Analyzing the data produced a student's probability of being shot. The model predicted that:

- ~200 students had a greater than 20 percent chance of being shot;
- ~1,000 students had a 7.5 to 20 percent chance of being shot;
- ~8,500 students had a 1 to 7.5 percent chance of being shot;
- ~100,000 students had a 0 to 1 percent chance of being shot.

This innovative application of big data helped inform CPS school safety and security practices. As a result of the analysis, CPS was able to intervene directly with students with the highest probability of being victims of violence. Additionally, CPS was able to allocate more dollars to safety, make new investments in social and mental health, slow the process of expelling students, and create new vehicles to drive parental involvement.

### Preparing students for the job market

Safely graduating from high school is not the end of the road for students. Going on to additional education, training, or a job is the goal. Yet preparing students for the contemporary workforce was not happening in CPS. In October 2011 Chicago hosted one of the country's biggest efforts to harness the power of big data to improve education through a groundbreaking collaboration between the Chicago Office of the Mayor, Chicago Public Schools, City Colleges of Chicago, and IBM. The goal of the project was to use big data to analyze the workforce in Chicago in order to inform the creation of new high schools created in partnership with private industry. The efforts led to the creation of five technology high schools in partnership with IBM, Microsoft, Motorola, Verizon, and Cisco.

The effort first sought to understand the Chicago career and technical education ecosystem to better educate kids for the jobs of the near future, as economic growth and job generation is dependent on education investments in career and technical education. Using multiple data sets from sources such as the Illinois Department of Employment Security (IDES) and Chicago Workforce Investment Council (CWIC), IBM conducted an analysis of the Chicago workforce landscape. IBM then created an analysis framework that assigned weights to (1) absolute number of jobs in 2018, (2) percentage growth in jobs from 2008 to 2018, and (3) median hourly wage.

From the data, IBM identified those positions that drove both demand for jobs and earnings, then performed a similar analysis using the CWIC data, examining positions that require associates degrees, certificates, and on-the-job training. They identified other employment trends that arise from a focus on two-year, post–high school education and examined the supply of student graduates by area of focus against the industry demand by position type. The idea was to build a school that better prepares students for and provides a path to employment and delivers a qualified labor force to area corporations. The effort developed and deployed a consolidated and systemic program model that uses multilevel business partnerships (anchor partners, advisory partners, supporting partners).

In January 2012 the IBM big data team delivered a strategy for a comprehensive career and technical education system for Chicago. The strategy would blend high school, college, and careers together into a new education model—a six-year school system for grades nine through 14 that includes a corporate sponsor.

The City of Chicago created five such schools with a focus on science, technology, engineering, and math (STEM) and information technology careers. Five technology giants have joined forces with Chicago Public Schools and City Colleges to open six-year public high schools that allow students to graduate with an associate's degree and the expertise they need to qualify for high-tech jobs. IBM, Cisco, Microsoft, Motorola Solutions, and Verizon will develop curricula, mentor students, provide summer internships, and guarantee every student who completes the program a "first-in-line" job interview after graduation.

In the future, the data analysis points to the need for new schools based on critical factors: jobs with rapidly changing skill requirements (in IT, specifically) and a new focus on healthcare professions such as registered nursing. There is a large number of job opportunities and higher-skilled positions in these areas, resulting in a higher income potential for Chicago students. Chicago programs should be developed to help students move from low-paid jobs into higher-skilled, higher-paid areas through IT skills. Those jobs, positions like

dental hygienist, medical-laboratory technician, electrician, aircraft mechanic, and entry-level software engineer, could allow many more young people entry into the middle class.

## Challenges for big data in education

A challenge for big data in education is implementation: taking the data and using it to help change policies and link studies with policymakers within CPS. The main obstacle is organizational. Distrust of big data is common when results are not politically favorable. They have the potential to embarrass city leadership, principals, and teachers. There is also a fear of confidentiality abuses of student data. Additionally, giving policymakers time to synthesize data can be crucial to acceptance of big data studies and the ability to act on their findings.

Another challenge is that educational strategies and priorities vary greatly, locally and internationally. Some schools employ an International Baccalaureate curriculum, while others are focused on STEM; some schools emphasize test scores, while others take a more holistic, student-centered approach. This can make coordination of data sets, collection, and analysis difficult. Still, there could be a lot to learn from a further engagement and integration of data collection, analysis, and systems.

## The future of big data and education

Big data brings the promise of broader and deeper analysis through the linking of health and safety data to education data sets. School attendance, which is at the intersection of health and education, is one of the biggest factors influencing educational performance. Health is a critical factor. School absences drive a lot of the gaps in education, so high-quality coordination between the healthcare sector and education sector is necessary. CCSR is currently working with the Office of Health and Wellness at CPS to help use data on kids' health to look at the relationship between health and school achievement. Health data can also be linked to student data outside of school.

Big data can potentially be used to extrapolate students' future job potential and earnings. Workforce outcomes can be examined through data linkages on kids' earnings as long as they are employed in Illinois when they finish high school. Workforce data linked to education data can inform postsecondary outcomes, careers, job outcomes, and earnings. As data-driven efforts are made to improve the quality of education in Chicago schools, additional data sets, in turn, enable new insights in other sectors related to education.

As evidence in this chapter shows, Chicago's use of data analysis is already having a positive impact on education policy and strategy. The partnership among the school system and the academic community (as well as other city departments) is an important characteristic of Chicago's model. As society's capacity to collect and analyze data increases, there will be more opportunities to comprehensively apply data expertise in education. It is essential that education data not be just about student academic advancement (including test scores and grades). Education involves a complex array of school-specific, systemwide, and societal factors. Socioeconomic, family, community, and health variables also impact our education system and must be included in data analysis. As long as decision makers do not lose sight of the real people and nuanced human factors behind the information, then using data to recognize problems and test solutions that improve outcomes is a tremendously positive frontier.

Chapter 5

# Big Data and Public Safety

Safety in schools and for students outside of the school setting is only a small sample of how big data can be used to increase the well-being of a community. Public safety—and particularly crime prevention and enforcement—is one of the most important functions of any city, whether in the developed or developing world. Worldwide, more than 500,000 people are murdered every year, and millions more are victims of other property and interpersonal crimes.[39] According to the University of Chicago Crime Lab, "Long-term progress in reducing crime—especially violent crime—has been limited."[40] Although mortality from virtually every cause of death has dropped precipitously in the past 50 years, murder rates in the United States remain at levels seen at the dawn of the 20th century.[41]

The use of big data to analyze, understand, and impact issues related to municipal public safety is perhaps one of the most promising applications of integrated data analytics to date. Increasing urbanization can lead to increasing crime unless smarter strategies can be developed to prevent and track it. In addition, municipal budgets face increasing constraints, and the imperative to craft effective social policy to enhance public safety is more important than ever. A number of cities—including Chicago—have deployed big data analytics in a variety of ways to address a host of problems that lead to and arise from crime. While many of these initial projects have been successful, they have raised a number of fundamental issues of justice, privacy, and democracy.

This chapter addresses both the promise and potential peril of the use of big data to understand, analyze, and act on issues of public safety in the modern city. While public safety has a number of facets, this chapter focuses principally on crime in terms of both prevention and policing. Other efforts to use big data to address public safety such as fire prevention and public health monitoring remain in incipient stages.

39. World Health Organization, *World Report on Violence and Health: Summary* (Geneva: WHO, 2002), http://www.who.int/violence_injury_prevention/violence/world_report/en/summary_en.pdf.
40. University of Chicago Crime Lab, "About Us," accessed May 13, 2014, https://crimelab.uchicago.edu/page/about-us.
41. Ibid.

## Chicago's big data public safety initiatives

Public safety agencies in the City of Chicago are using big data to create a safer city. Chicago is using existing data to centralize command and control of law enforcement and public works agencies and identify individuals and locations in need of services. In 1995 the City of Chicago unveiled the Chicago Emergency Communication Center (CECC), a 161,000-square-foot, state-of-the-art facility.[42] The CECC consolidated emergency communications for police, fire, and emergency medical services.[43] At the time the CECC was established, it had a 176-mile fiber optic network to connect the CECC and all police districts and areas.[44] After September 11, 2001, the CECC became the Office of Emergency & Communication (OEMC). In 2010 the plan for the CECC and its fiber optic network came to fruition.[45] The mission of the OEMC is to manage emergency responses, coordinate events, operate communication systems, and provide technology.[46] The OEMC houses 911 call center operations; police, fire, emergency medical service, and public works dispatch operations; and Police Department and Fire Department command and control centers.[47, 48]

The OEMC has two main functions. First, it acts as a centralized command center for city services. It coordinates various functions of the city's organizations to quickly react to situations, including fires, accidents, and power outages.[49] The city also uses the command

42. City of Chicago Police Department, https://portal.chicagopolice.org/portal/page/portal/ClearPath/Get%20Involved/Hotlines%20and%20CPD%20Contacts/CECC.
43. Ibid.
44. Ibid.
45. Interview with Commander Jonathan Lewin, managing deputy director, Public Safety Information Technology, Chicago Police Department/Office of Emergency Management and Communications, February 10, 2014.
46. See http://www.cityofchicago.org/city/en/depts/oem.html.
47. Interview with Commander Jonathan Lewin.
48. See https://portal.chicagopolice.org/portal/page/portal/ClearPath/Get%20Involved/Hotlines%20and%20CPD%20Contacts/CECC.
49. Interview with Commander Jonathan Lewin.

center during large events such as the 2012 NATO summit to ensure law enforcement and public works can support and monitor events and activities and quickly respond to emergency situations.[50]

Second, the OEMC also supports efforts to cross-reference law enforcement information with public works information.[51] The use of big data allows law enforcement to create a more accurate picture of the city's criminal landscape and analyze various factors that may affect criminal activity. The City of Chicago is able to use the data to identify actors that contribute to the decay of neighborhoods. Big data is also used to create a more comprehensive profile of current/future offenders and available intervention services. For example, the City of Chicago has cross-referenced law enforcement data and housing data to identify abandoned buildings where crime occurs and then notify building owners of their liability.

In addition to the OEMC, the University of Chicago Crime Lab is using big data to provide social services to high-risk youth in an effort to direct their lives away from crime and keep them in school, as noted in the previous chapter. The Crime Lab was established in 2008 with the mission of using insights from basic science to help government agencies and nonprofit organizations use new approaches to reducing violence and then test those new techniques using rigorous evaluative methods.

### Prevention strategies

The City of Chicago is using its collection of data to create a prevention strategy by focusing on "hot people" and not only on "hot spots."[52] A study by Chicago-born sociologist and professor at Yale, Andrew Papachristos, suggests that a person's "social network is a key predictor in whether an individual will become a victim of gun homicide, even more so than race, age, gender, poverty, or gang affiliation."[53] The Chicago Police Department (CPD) is using this theory to prevent crime. The CPD is using data to create social networking maps of defendants and victims to predict future behavior. This effort assists law enforcement in identifying "parties to violence," individuals who are likely to become victims or perpetrators of crime.[54] The social networking theory not only considers the relationships of individuals, but also considers gang affiliation, criminal history, and other factors that would identify parties to violence.[55] However, the theory does not include the individual's race or gender when mapping the social network.[56]

Once parties to violence are identified, the CPD participates in intervention strategies to engage them. The intervention has been called "Hug-a-Thug."[57] The process begins when CPD commanders in local police districts where the individuals live, along with the heads of community antiviolence programs or social service advocates, visit the parties to violence and their families to explain how their criminal history and social networks have placed them on a list as parties to violence.[58] The individual is offered social services and an opportunity to change their lives.[59] During these interventions, they are told that they are likely to become a victim of a homicide if they don't change the way they are living.[60] By involving local police commanders, the program capitalizes on the knowledge the officers have gained while working in the neighborhoods and communities. The intervention will hopefully deter the individuals from participating in criminal behavior and help them avoid high-risk situations, which may result in becoming a perpetrator or victim of violent crime. The Chicago Police Department's intervention program is an effort to help the at-risk resident of Chicago rather than solve the problem with arrests and prosecutions.[61]

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50. Ibid.
51. Ibid.
52. See http://www.nbcnews.com/news/us-news/small-world-murder-homicides-drop-chicago-police-focus-social-networks-v21864122.
53. Amy Athey McDonald, "Study finds social networks are key to city violence," *Yale News,* November 14, 2013.
54. Interview with Commander Jonathan Lewin.
55. Whet Moser, "The Small Social Networks at the Heart of Chicago Violence," *Chicago Magazine,* December 9, 2013; Interview with Commander Jonathan Lewin.
56. Interview with Commander Jonathan Lewin.
57. Frank Main, "Top cop 'optimistic' that visiting gang leaders' homes cuts violence," *Chicago Sun-Times,* February 24, 2014, http://www.suntimes.com/news/25722451-418/top-cop-optimistic-that-visiting-gang-leaders-homes-cuts-violence.html.
58. Amy Athey McDonald, "Study finds social networks are key to city violence"; Interview with Commander Jonathan Lewin.
59. "Police Supt. McCarthy on Crime, Gangs & More," *Chicago Tonight,* February 27, 2014,http://chicagotonight.wttw.com/2014/02/27/police-supt-mccarthy-crime-gangs-more.
60. Ibid.
61. Amy Athey McDonald. "Study finds social networks are key to city violence."

While the current intervention program addresses immediate at-risk individuals, the social networking theory may provide law enforcement and social services agencies with the information needed to establish services to communities and/or social groups.[62] Social networking may provide the map where law enforcement and public service agencies can implement strategies geared toward social communities to better serve at-risk populations. This approach will offer solutions to more systemic problems within social groups/communities, hopefully providing a proactive strategy for reducing violence.[63]

From the summer of 2013, when the Hug-a-Thug intervention program began, until February 2014, the CPD has participated in 60 intervention meetings. Seventeen individuals have accepted the social services offered to them to help change their lives. Two individuals who refused the CPD's offer have become victims of violence.[64] On December 26, 2013, one of them, a 27-year-old male, was walking with his girlfriend in the West Garfield Park neighborhood when two individuals approached and shot him multiple times in the chest and head. He was pronounced dead at Mt. Sinai Hospital.[65] Approximately five months prior to this murder, the CPD had identified the victim as a "party to violence," and the CPD commander from the Austin District had contacted him.[66] He told police that he was moving from Chicago,[67] which could have separated him from the social network that placed him at risk.

### Identifying proven crime prevention programs by quantifying outcomes

With the estimated social cost of gun violence in Chicago at $2.5 billion per year,[68] the city continues to search for interventions that will interrupt the cycle of youth violence and crime. To do this, the city is relying on collaboration with the University of Chicago Crime Lab to identify programs with proven outcomes. The Crime Lab leverages data throughout its process, both predictively and analytically, to provide critical information that the city can use to most efficiently allocate their scarce resources to combat youth violence and crime.

One example of the Crime Lab's work is the evaluation of the Becoming a Man (B.A.M.) program. B.A.M. was created by the Chicago-based nonprofit Youth Guidance to equip at-risk male students with the cognitive-behavioral tools needed to strengthen impulse control, which research indicates is a key factor in many youth-based violent crime incidents. B.A.M. includes skill building such as emotional self-regulation, reading social cues, positive peer relations, raising aspirations for the future, and developing a sense of personal responsibility—all important tools for reducing antisocial behavior.

Equipped with a research-grounded program methodology, Youth Guidance and the University of Chicago Crime Lab launched B.A.M. in 2012. Chicago Public Schools (CPS) provided administrative data that included factors like attendance, performance, and behavior that was used to identify 2,740 seventh to tenth grade at-risk males for participation in the study. A lottery was used to select the 800 participants that would receive the B.A.M. intervention as part of the randomized controlled trial.[69]

Extensive data was collected and analyzed through the study. The first validation came early. The Crime Lab team lacked access to police and court records when they were selecting the 2,740 person sample; however, once access to these records was gained, the predictive value of even the single CPS data set became apparent—one-third of the 2,740 selected study participants already had a documented arrest.[70] This was a preliminary indication that behavioral indicators are good at predicting violent crime involvement.

At the conclusion of the study, CPS administrative data was cross-referenced with arrest reports and court proceedings. After analysis, the randomized controlled trial revealed the impact of the B.A.M. program was significant: a 36 percent reduction in weapons crime and vandalism, a 44 percent decrease in violent crime arrests, and a

62. Whet Moser, "The Small Social Networks."
63. Ibid.
64. "Police Supt. McCarthy on Crime, Gangs & More."
65. See http://chicago.cbslocal.com/2013/12/27/man-shot-and-killed-in-west-garfield-park-2/.
66. Frank Main, "Top cop 'optimistic'."
67. Ibid.
68. Roseanna Ander, Philip J. Cook, Jens Ludwig, and Harold Pollack, *Gun violence among school-age youth in Chicago,* The University of Chicago Crime Lab, March 2009, http://crimelab.uchicago.edu/sites/crimelab.uchicago.edu/files/uploads/Gun_Violence_Report.pdf.
69. Jeff Nesbit, "In Chicago, Proof Positive That Mentoring Decreases Youth Violence," *US News,* October 4, 2012, http://www.usnews.com/news/blogs/at-the-edge/2012/10/04/in-chicago-proof-positive-that-mentoring-decreases-youth-violence.
70. Ibid.

10 to 23 percent increase in graduation rates.[71] The calculated return on every $1 invested in the B.A.M. program was an astounding $34.[72]

Big data analytics were instrumental in tracking and quantifying the impact of the program through a data-rich, randomized controlled trial. And the Crime Lab's use of big data in its evaluation analytics continues to grow; recent iterations of the study have included victimization data and market outcomes. At a time when funding is increasingly limited, big data analysis offers a means to assess programmatic effectiveness in crime prevention program delivery and thereby more efficiently allocate resources. Few crime prevention programs have quantified, demonstrated impact outcomes, and B.A.M., in partnership with the Crime Lab, has demonstrated that "good evaluation does not have to cost-prohibitive," but that a collaborative government that facilitates sharing of administrative data is a key ingredient for success.[73] Equipped with outcomes-based evidence driven by big data analysis, policymakers can more efficiently allocate finite resources to interrupt the cycle of youth violence.

## Challenges for big data and public safety

Data collection is growing in volume, velocity, variety, and veracity at an exponential rate, and public safety–related data are no exception. Analogue documents and processes such as arrest report and court records are now being digitized, increasing the volume and velocity of the information available. Video cameras and sensors are providing near real-time updates about where and when crime is happening. The expansion of data-generating consumer devices and the movement of other industries to digitization—such as healthcare moving to electronic medical records and the property assessor opening access to abandoned building data—has produced a greater variety of data that can yield correlations and insights into issues of public safety. Improvements in the accuracy of geospatial positioning, which allows for accurate and instant location services for squad cars and public transit, for example, are improving the precision of the data.

### Data incompatibility

Despite the increases in the quantity, speed, diversity, and accuracy of the data collected, translating that data into informative, actionable information that can be leveraged for prediction, evaluation, or decision making is fraught with challenges. The data are often in different formats, unstructured, and/or uncategorized. For example, the fields included in court reports vary by jurisdiction such that different courts in the same city may report different information in their documents. Similarly, data collected on foreclosed and abandoned buildings may not contain descriptive tags, which means the contents are only useful to the database creator. For data to be compatible across sets, a new level of data standards and reporting rigor is required.

Advancements in technology and analytics are also necessary to make the available data useful. As demonstrated by the Citizen and Law Enforcement Analysis and Reporting (CLEAR) example in Chicago, technologies are emerging to parse and/or aggregate, synthesize, model, and visualize multiple data sets simultaneously. One currently available product, N-DEx, is a "cloud service capable of processing criminal information and returning results in fractions of a second over secure Internet links. It is also a big data application, comprising roughly 200 million law enforcement records and more than 1.5 billion data points."[74]

Moving the data into a usable state will open the door for advanced analytics to turn independent and seemingly unrelated data sets into valuable predictive and evaluative information for law enforcement and other public safety officials.

### Privacy concerns

Chicago Police Department programs raise what is perhaps the most pressing question facing the use of big data for public safety: privacy. Big data provides a treasure trove of information for government actors. However, when viewed in the light of law enforcement, national security, public health, and limited resources, there

71. Youth Guidance, "News," http://www.youth-guidance.org/category/partner-spotlight/.
72. Roseanna Ander, "Evidence based violence reduction strategies," Conference presentation, August 6, 2013, http://www.ncja.org/sites/default/files/documents/Roseanna-Ander-Presentation-NF2013.pdf.
73. Ibid.
74. Brad Grimes,"Big data is taking a byte out of crime," *Fed Tech*, October 28, 2013, http://www.fedtechmagazine.com/article/2013/10/big-data-taking-byte-out-crime.

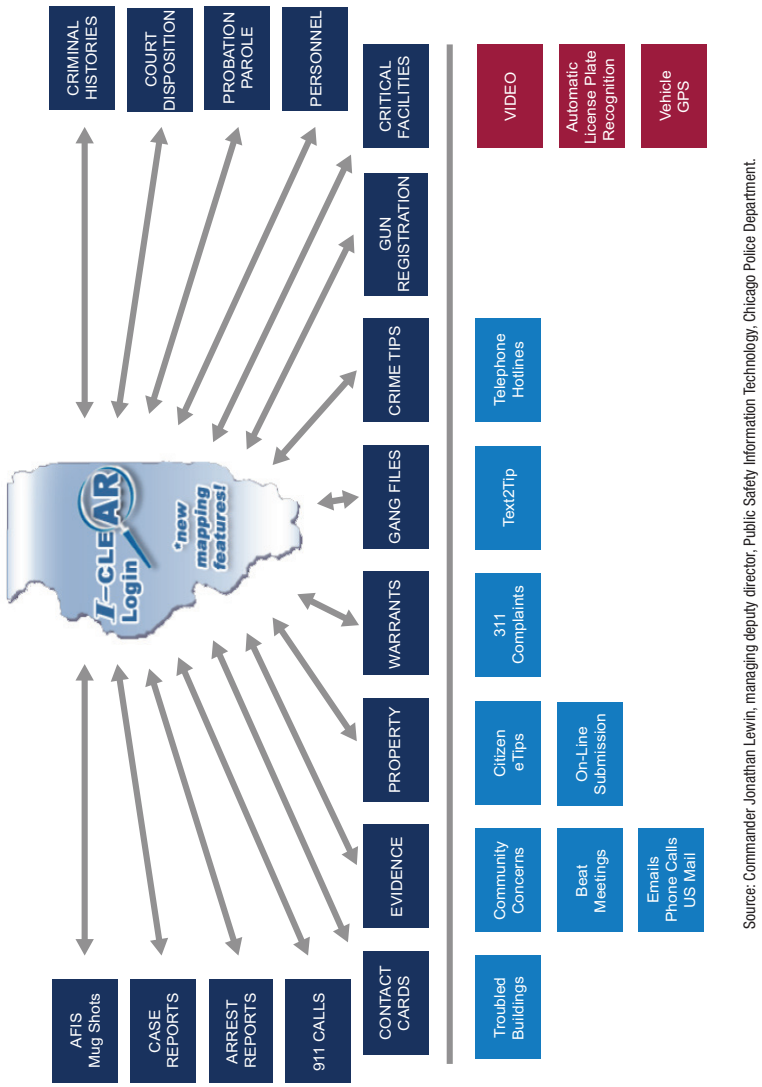


**Figure 8 – Many cities are using big data to pursue and optimize municipal projects.**

Source: Commander Jonathan Lewin, managing deputy director, Public Safety Information Technology, Chicago Police Department.

has to be a balance that addresses the public's safety and privacy concerns.[75] Finding the right balance between privacy risks and the potential benefit of big data poses a significant public policy challenge for municipal governments.[76] Privacy and security do not have to be mutually exclusive. Law enforcement agencies should be capable of providing adequate security while guaranteeing that individual privacy will not be unreasonably infringed upon. Yet heightened public scrutiny demands that policymakers rethink the balance between security and privacy without compromising or unnecessarily limiting the potential of big data application.

Chicago, like many cities, has a wide array of agencies that store or have access to vast amounts of internal data that are typically for use by that agency only. The data are subject to legal limitations on interagency sharing and agency rules and regulations. For example, city government departments such as the Chicago Police and Chicago Public Schools each have their own data and do not share personalized data. From a public safety perspective, the sharing of information between the Chicago Police and Chicago Public Schools may seem logical to aid policing, monitoring, and response. However, the routine sharing of data between agencies raises major concerns regarding privacy, profiling, the potential for overreach, and data management in the case of security breaches.

Author Matt Stroud, in his article "The minority report: Chicago's new police computer predicts crime but is it racist?"[77] contends that "the jury's still out about whether Chicago's heat list and its other predictive policing experiments are worth the invasions of privacy they might cause and the unfair profiling they could blatantly encourage."[78] Such statements illustrate that while big data analysis and predictive analytics can and do enhance traditional law enforcement techniques, they can create difficult legal and social hurdles.

Nevertheless, Chicago is one of the global cities demonstrating through its law enforcement efforts that limited resources and legal constraints concerning privacy do not have to be a hindrance to law

75. Omer Tene and Jules Polonetsky, "Privacy and Big Data: Making Ends Meet," *Stanford Law Review,* 66 Stan. L. Rev. Online 25 (September 3, 2013), http://www.stanfordlawreview.org/online/privacy-and-big-data/privacy-and-big-data.

76. Ibid.

77. Matt Stroud, "The minority report: Chicago's new police computer predicts crimes, but is it racist?" *The Verge,* February 19, 2014. http://www.theverge.com/2014/2/19/5419854/the-minority-report-this-computer-predicts-crime-but-is-it-racist.

78. Ibid.

## Box 4 – Sources of data utilized in public safety calculations

- Cameras and video feeds
- Private-sector data, including consumer
- Geospatial data from squad cars, public transportation, and cell phones
- Reported crime database
- Arrest records and court documents
- Health records
- Vacant and abandoned building locations
- Social media
- Sensors
- Voice data, including 911 calls
- Weather events/forecasts

Source: Anthony Garcia, Jamie Jones, Nirav Shah, Courtney Thompson.

enforcement capabilities. Through collaborations with institutions such as the University of Chicago Crime Lab,[79] which can receive nonpersonalized data from various city agencies (subject to strict confidentiality and use agreements), innovative public safety initiatives can be undertaken.

These collaborative partnerships that optimize the available data by linking nonpersonalized information between agencies such as the Chicago Police and Chicago Public Schools help meet the twin challenges that are raised by residents, privacy advocates, and public safety enforcement institutions. The research, analysis, and optimization of data[80] undertaken at public and private institutions such as the Crime Lab can and are being used to help policymakers, stakeholders, and law enforcement craft and tailor initiatives to meet their day-to-day challenges through access to data while maintaining the anonymity of individuals. Chicago, therefore, is a notable example of a collaborative system where a city government and public safety organizations collaborate with academia to develop effective and innovative enforcement strategies.

Two other approaches can also help address privacy issues. First, by seeking judicial approval through standard warrants, law enforcement can help ensure that the rights of innocent persons are not trampled by a police dragnet. Judicial oversight may also help build public trust in law enforcement initiatives.

Second, the benefits of gaining public trust and support cannot be underestimated. Greater transparency and information campaigns can help the public better understand what information is being collected, how it is being used and why, and the benefits for public safety. Without such understanding and trust, initiatives may be doomed to failure regardless of their efficacy. Efforts by law enforcement to ease public fears, on the other hand, can have positive results. For example, when cameras were placed in the Chicago neighborhoods of Humboldt Park and West Garfield Park, many residents and community groups were upset for a variety of reasons. Once law enforcement and city representatives worked with them, these issues were resolved. This suggests that simple solutions such as public hearings, community meetings, and efforts toward transparency on the front end will provide dividends at the back end. Creating an operational and effective public surveillance system is a large undertaking, and it should be made with all members jointly committed to its success. Examples such as this also offer valuable information on what the public may be willing to accept and live with.[81]

### Cost

Cities and governmental organizations are constantly faced with two distinct challenges where data and security are concerned: (1) limited resources and (2) securing their vast pools of data. Despite the ever-increasing challenges that cities face in providing public safety, the needs are far outpaced by the available funding in city budgets. In order to keep up with the rising safety costs and the needs of public safety, cities such as Chicago are either hiking fees or increasing

79. Interview with Roseanna Ander, executive director, University of Chicago Crime Lab, February 5, 2014.

80. Accenture, "Preparing police services for the future," Report 2013, http://www.accenture.com/SiteCollectionDocuments/PDF/Preparing-Police-Services-Future.pdf/.

81. Nancy G. La Vigne, Samantha S. Lowry, Joshua A. Markman, and Allison M. Dwyer, "Evaluating the Use of Public Surveillance Cameras for Crime Control and Prevention," Urban Institute Justice Policy Center, September 2011, http://www.cops.usdoj.gov/Publications/e071112381_EvalPublicSurveillance.pdf.

fines to curb budget shortfalls and declining city revenues.[82] This limitation has forced a growing number of cities to do more with less and find innovative ways to achieve even better outcomes. One of the consequences of limited budgets has been increased reliance on data to effectively and efficiently manage use of resources and to respond to demands of public safety. In Chicago, for example, the Chicago Police Department does not get funding for new servers frequently. Due to budgetary constraints, it uses older equipment until it crashes before getting new equipment.[83]

Big data has allowed the city and particularly the Chicago Police Department to better direct resources to the most-needed areas. The intersection of data sets, for example, between health, education, and safety, can help policymakers better focus enforcement programs on communities where the programs can yield the best results. The Chicago approach has shown that even with limited resources, big data analysis enhances effective policing and guides careful allocation of limited resources.

Finally, it is important to note that big data does not automatically yield good analytics, nor does it guarantee positive outcomes.[84] The value of the data sets available is best illustrated in how they are used and the outcomes that can be measured and evaluated. Credible data and an accurate interpretation of the data are necessary to get the most out of it.[85]

### Data security

Big data also raises concerns about securing available data and what happens in case of a breach. As evidenced by the recent National Security Agency (NSA) scandal, a fresh focus has been placed on ensuring stricter controls on data by organizations across the board. The NSA breach made clear that data breaches could occur via internal or external actors. As a consequence of the NSA breach, the burden to ensure tighter controls or protection of data on holders or "owners" of big data has recently increased. In Chicago, the data available to the city from institutions such as the University of Chicago Crime Lab are highly secured in a multilayered system, making access difficult.

Sensitive Crime Lab data, for example, are kept on a central server that is used only by the Crime Lab. The server is housed in a climate-controlled and power-regulated data center, where physical access is restricted to authorized personnel. The cabinet containing the server is also locked against unauthorized physical access. The server is protected by a host-based firewall that restricts traffic on all ports and allows connections only from machines connected to the secure campus network. The university's campus network is constantly monitored by computer security specialists and is updated and patched regularly by dedicated information technology services staff employed by Crime Lab to secure against software vulnerabilities. The server runs intrusion detection software, which monitors all critical system files for unauthorized changes. System logs are monitored via constant automated problem detection software and daily by the Crime Lab's server administrator. Only Crime Lab staff authorized to work with sensitive data are given access to the server, and access is restricted only to directories necessary for completion of approved analytical tasks for each staff member. All analysis is carried out on the server; data is never downloaded to an individual's computer.[86]

While the University of Chicago example is commendable, it highlights the fact that agencies and organizations need to understand that big data initiatives require a fresh focus on data security. Big data security should match the controls of source systems. Data warehouses and big data solutions should include their own security features. Organizations are well advised to perform risk assessments of their data stores and identify where they need to apply security solutions. Organizations and city governments need to focus on trusted security measures such as role-based access control to big data sources, network access controls, operating system hardening, and encryption of data at rest and in transit.[87]

## The future of big data and public safety

A number of exciting opportunities for the use of big data are looming on the horizon. As cities generate more and more data each

82. Ellyn Fortino, "Breaking Down Emanuel's 2014 Chicago Budget," Progress Illinois, http://www.progressillinois.com/posts/content/2013/10/24/breaking-down-emanuels-2014-chicago-budget.
83. Interview with Commander Jonathan Lewin.
84. Taylor Armerding, "Big Data without good analytics can lead to bad decisions," CSO Online, August 26, 2013, http://www.csoonline.com/article/print/738754.
85. Interview with Roseanna Ander.
86. Ibid.
87. CDW-G, "Proactive Planning for Big Data," White Paper, 2013, http://www.fedtechmagazine.com/sites/default/files/122210-wp-big-data-df.pdf.

year, the number of data sets for use and analysis will also expand. This expansion of available data has profound implications for the future successes of big data. Provided cities make these data easily accessible to researchers, planners, and law enforcement authorities, the possibilities for future applications of big data are seemingly boundless.

Increases in computing power, too, will have a tremendous impact on the ability of big data to play a role in public safety policy. As computational power becomes more sophisticated, big data may be able to move from analyzing public safety issues to playing an active role in their resolution. For example, advanced machine learning techniques are being studied for their potential to analyze data in real time. These algorithms could potentially aid decision making on various public safety issues. For example, machine learning could aid judges in setting the appropriate bail bond rates for accused offenders. Presently, such rates are based on a variety of disparate factors, resulting in what are often wildly divergent figures for similar offenders. Combining a multitude of data on accused offenders with an advanced artificial intelligence system could result in more even, calibrated bond rates. The promise of such an outcome has fundamental implications for justice and democracy.

As cities continue to grow, their increasing size and density bring risks of growing crime rates. And in light of shrinking budgets, city planners will be under pressure to devise creative, effective solutions to both preventing and policing crime. In this environment, the ability of big data to generate cost-effective solutions to issues of public safety is more relevant than ever.

Despite impressive progress to date, the application of big data to problems of public safety is still in its infancy. Cities have a central role to play in leading the maturation of this field, and the City of Chicago offers a number of best practices for other cities that are considering whether and how to venture into this territory.



# Chapter 6

## Best Practices from the Chicago Experience

The use of big data to support more efficient municipal activities is an inevitable trend that will help determine whether municipalities prosper or wither. Cities that are taking steps now to harness and act on the data available to them are developing sustainable, competitive advantages that will benefit their residents and businesses in both the near and long term. For cities to realize these benefits, it is vital to define what a successful big data rollout entails and build a robust strategy to guide the effort.

Through our research across the sectors of energy, transportation, education, and public safety in Chicago, we have identified what we believe to be a core set of factors that must be included and explicitly addressed in any municipal big data strategy.

### Lead big data initiatives from the top

For a big data strategy to work, it is vital for the city's chief executive to have a defined plan to capture data and a clear vision of how to make this data useful to decision makers. Big data initiatives cannot be embarked upon in a piecemeal fashion. Significant economic and political capital is required to capture the benefits and actually turn data into information. Because of the inherent interdependencies of leveraging large data sets to support decision making, it is difficult and ineffective to create piecemeal systems that are not internally aligned and well structured, with an organic means of measuring success. Big data is a tool that can increase efficiency, expand productivity, promote sustainability, and improve the quality of life. But to be of maximum impact, big data must be considered and used in the broader context of creating and sustaining a world-class city. It is not enough to develop a design or empower a chief technology officer. Instead, the vision must be consistently incorporated into the expectations at all levels of the municipal government, changing behaviors and requiring adaptations to decades-old policies.

Chicago Mayor Rahm Emanuel has embraced this type of leadership. Through executive orders and an ambitious technol-

ogy plan, he is building the city's commitment to technology leadership through a modern infrastructure, smart communities, and technological innovation. The creation of a cabinet-level position to identify, integrate, and share big data for the city further embeds this commitment.

## Collect appropriate and quality data

The first step in realizing the benefits of a big data strategy is capturing high-quality, accurate, granular data. This requires interoperable database systems that can automatically communicate across departments in an electronic and analyzable format. In addition, this data must then be consistent with outside data sources that can be used to provide a broader picture of the challenges being addressed.

Cities have an opportunity to lead in this regard. Cities should take steps now to ensure that their IT infrastructures are capable of capturing the relevant data and generating databases that will serve as the backbone for big data analytics. As with any IT venture, the process of updating existing IT infrastructure (or creating it wholesale) can be costly. Although budgetary constraints may hamper efforts to modernize IT systems, early evidence suggests that such investments—especially in the area of public safety—may yield dividends. Indeed, the examples cited throughout this report, including Chicago's Citizen and Law Enforcement Analysis and Reporting (CLEAR) and Becoming a Man (B.A.M.) initiatives suggest that the use of big data analytics can be a powerful tool to maximize social impact dollar for dollar. Indeed, many cities may already be collecting these data. From there, the next step—to analyze them and devise policy to address social issues—may be politically and practically more feasible than the initial collection efforts.

The City of Chicago has taken steps to increase its internal capabilities for data collection and management. As previously discussed, data sets that were scattered across a number of city departments have been centralized. Many of the functions that were previously completely manual are now being automated. Though the projects are not complete, they show the benefits that are possible through this process. Dedicated focus and continued improvement to these projects must be applied for the data to remain relevant and actionable.

But it is not sufficient to simply collect more data. Cities should implement a measured, forward-looking posture that considers not just what data should be collected, but whose data. Cities should begin planning to ensure that the data collected on residents are representative of society. In matters of public safety, for example, it may be tempting to focus data collection efforts on neighborhoods experiencing the highest levels of crime. This strategy of "looking where the light is shining" is fraught. It may leave city officials open to charges of racism by activist groups who see prevention and policing efforts as unfairly targeting their neighborhoods.[88]

## Ensure data sharing, public access, and collaboration

The sharing of data—among city agencies and with external partners and the public—is critical to fully leveraging the benefits of big data. In Chicago, Mayor Emanuel has made the availability of data a core component of his administration. His 2012 executive order requiring all city agencies to collect and make available appropriate data on the city's data portal highlights the belief that better access to and analysis of data are the foundation on which efforts to improve the city and help it thrive in the 21st century are built. Over the past three years, the city has used data to support economic development and city livability by making a vast number of databases available to the public. The mayor has also spoken of opportunities to further incorporate data-driven decision making into the standard operating procedures of every department and sister agency.

Through the transparent availability of large data sets, Chicago is committed to becoming a leader in the capture and publishing of municipal data. This has supported the development of a start-up ecosystem, which uses the data to create software applications that can be monetized and grown. These applications are then used by residents to make living in the city easier and more efficient, creating a virtuous cycle.

As demonstrated throughout this report, collaboration and data sharing among city agencies and with external partners has also been a key component of big data initiatives to address a range of public policy issues and has yielded positive results for the city and its residents. Such collaboration has been enabled by both the commitment to data availability as well as a commitment to leveraging independent talent and expertise through external partners. From collaborations in energy like the Illinois Smart Grid Regional Innovation Cluster; to those in education and public safety among the Chicago Public Schools, the Chicago Consortium on Chicago

88. Matt Stroud, "The minority report."

School Research, the Chicago Police Department, and the University of Chicago Crime Lab; to those in education among private-sector companies like IBM, Cisco, Microsoft, Motorola Solutions, and Verizon and Chicago Public Schools and City Colleges of Chicago, collaboration has been indispensable to big data initiatives.

## Put safeguards in place for data security

In the coming years, those who devise and conduct sophisticated models drawing upon multiple administrative databases will have access to a virtually unlimited amount of information about the public. In practice, that information is typically scrubbed and anonymized prior to publication. But the servers that house the data may still retain this protected, private information. Therefore, cities as well as any other actor with access to integrated databases used in large-scale analytics should ensure that appropriate safeguards (e.g., firewalls, strong passwords, identity confirmation, and limited access) are put into place so these data sets remain out of bounds of hackers and other unauthorized users.

## Address privacy concerns

With respect to privacy, critics charge that as data gets "bigger" and analytics become more powerful, government agencies will be able to understand and predict more about the behavior of residents than ever before. But it's not clear how these concerns represent a difference in kind, or just a difference in degree. In Chicago, barriers remain between key databases that could yield significant benefits if analyzed together. However, valid concerns continue to be raised about the near and long-term implications of sharing individual data for highly sensitive decision making. In order to strike a balance between beneficial uses of data and the protection of individual privacy, policymakers must address some of the most fundamental concepts of privacy law.[89] This debate is not one that has a clear right or wrong, yes or no answer, but is a discussion that must be undertaken in the public domain, with findings then incorporated into the data collection and analytics processes.

89. Omer Tene and Jules Polonetsky, "Privacy in the Age of Big Data: A time for big decisions," 64 Stan. L. Rev. Online 63 (February 2, 2012), http://www.stanfordlawreview.org/online/privacy-paradox/big-data.



Many current uses of big data simply augment standard tools that have been available for decades. However, city departments are attempting to overcome privacy challenges by using anonymous data wherever possible to capture the key insights that databases can provide, without improperly infringing on the rights of the individual. City officials need to be careful to use integrated data analytics in ways that do not violate the Fourth Amendment, and judicial approval, when appropriate, may go a long way towards ensuring that the rights of innocent people are protected. Judicial approval also enhances the public's perception of such approaches and may foster trust between city government and the public.

## Gain public support

Public perception matters greatly. Even if the use of big data faces no legal obstacles, cities should embrace transparency in their processes to help foster "buy in" from the public. While it is important to strive to maintain the delicate balance between uses of big data for the public good and privacy, the public has to be better prepared and informed about the reality of today's challenges and how big data can address them. All stakeholders, including politicians, public administrators, and law enforcement officials have a continued responsibility to educate, inform, and manage the ever-rising expectation of residents. A failure to inform residents of what data are being collected, how it is being used, and what opportunities are possible as a result may result in a backlash that could undermine the public's trust and, ultimately, the effectiveness of big data initiatives. Whether the programs are ultimately successful may be irrelevant to the public's perception of them. If the programs are seen to undermine the "social contract" that exists between government and the people because of perceived privacy violations, no amount of efficacy data will save the initiative.

## Fund outcome-based evidence on what works

While big data offers the opportunity to arm decision makers with critical, actionable information at relatively low cost, this can only happen if policy outcomes based on this information can be quantified and proven effective. Evaluation is critical to allocating scarce resources to programs that will have an actual impact. As illustrated in chapter 6, for example, collaboration between the City of Chicago

and the Chicago Crime Lab yielded effective program assessment that was not cost-prohibitive and that can identify programs with a significant return on investment.

## Conclusion

As the world's center of gravity continues to move towards urban centers and megacities, the competition for residents will only increase. As we have seen in Chicago over the past decade, the city government has focused on attracting both talent and businesses to locate within the city limits to ensure a vibrant economic environment, while also providing a more stable economic base to support robust city services. This type of competition will allow the most successful megacities to create virtuous cycles, with the economic and quality-of-life benefits compounding to support even greater growth.

The use of big data has the potential to start that virtuous cycle by allowing smart city leaders to best leverage scarce resources (both financial and political) to increase the quality of life for city residents. Cities that are able to grow and attract top talent in computer sciences, engineering, and analytics will have the greatest competitive advantages, as these skills are necessary for data to become useful and actionable.

Big data will grow in its application, contribution, and importance to the way organizations achieve efficiencies, make decisions, and serve their constituencies. This is particularly true for cities, where true convergence occurs between an information infrastructure impacting huge numbers of people and a small set of decision makers. The way this data is amassed, utilized, and publicized can greatly impact the overall lives of the human populace, but only if those amassing the data develop, or are bound by, sound public policy initiatives protecting the privacy of the individual.

Therefore, the promise of big data lies with the professionals who will generate and institute the policies that push society forward in the information age. These individuals should ensure that the implementation of policies is done in accordance with each city's values and culture and in keeping with democratic and legal principles that enshrine justice, privacy, and fairness.

The 2014 EL cohort is optimistic about the opportunities afforded by big data and the steps that Chicago has taken. By committing to both use data to drive decisions, while also making data available to residents and the entrepreneurial community, Chicago has begun to create the foundation for the rise to megacity status. However, it is vital that Chicago continue to not only look for new and innovative opportunities to use data to increase the effectiveness of government operations, but also to support the innovation ecosystem that has begun to develop within the city and the region. It is with these investments that Chicago will continue to play a leadership role in the global community.

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# Biographies: Emerging Leaders Program Class of 2014

**Kamran Bajwa**
*Corporate Partner*
*Kirkland & Ellis*

Kamran specializes in handling highly complex international legal matters with a focus on the Middle East and emerging markets. In addition to his professional work, Kamran has served as an advisor to major international NGOs in the United States, Europe, and the Middle East relating to intercultural dialogue. From 2003 to 2010 Kamran and his family lived in Dubai, Cairo, and Bahrain, and his work experience includes time spent in over 20 countries across Africa, Europe, the Middle East, and Asia. Kamran is a graduate of the University of Michigan Law School (1999), has studied classical Islamic theology, and is fluent in Arabic and Punjabi.

**Aileen Furlong Caffrey**
*Managing Director, Mileage Plus*
*United Airlines*

Aileen leads premier programs and global air partnerships for Mileage Plus. Under her leadership in 2011, Mileage Plus was named Best Elite-Level Program in the Americas for the second straight year at the Frequent Traveler Awards as well as Best Frequent Flyer Program by *Global Traveler* magazine. She was also instrumental in leading the integration of Mileage Plus and Continental's OnePass programs to create the world's leading loyalty program. Since joining United in 2000, Aileen has launched new routes, products, partnerships and promotions and has held a variety of senior management positions in loyalty and marketing. Aileen earned her BA from Georgetown University and her MBA from the Kellogg Graduate School of Management.

**Lincoln S. Ellis**
*Managing Director and Senior Strategist*
*Green Square Capital*

Lincoln leads Green Square's strategy and business development practices and heads the firm's Chicago branch, Green Square's first office outside of Memphis. Lincoln created Columbia University's Columbia International Affairs Online (ciaonet.org), one of the first and most comprehensive databases for theory and research in economics and international affairs on the web. Prior to joining Green Square in 2013, Lincoln held positions at Morgan Stanley's Private Wealth Management, covering ultra-high-net-worth families and family offices. He also started two hedge fund businesses and Astor Janssen Holdings, a consulting company. He is recognized for a unique outlook that combines the rational science of economics and the irrational art of market investing. He has appeared on CNBC, Bloomberg TV, Fox Business, CNN, SKY News, BBC, and NPR's Market Place Morning Report and is a frequent contributor to the CME's daily market commentary operation. He is one of the original contributors to Nouriel Roubini's Economonitor, where he occasionally blogs.

Lincoln received his bachelor of arts in political science from Valparaiso University and his master of arts in politics from the Graduate Faculty at the New School in New York City.

**Anthony P. Garcia**
*Senior Counsel, Litigation and Investigation*
*The Boeing Company*

Prior to joining Boeing in 2013, Anthony was with the US Department of Justice. His last assignment was to the Gangs and Narcotics Section in the US Attorney's Office for the Northern District of Illinois. He served as the US Department of Justice attaché assigned to the US embassy in Mexico City, Mexico, from 2009 to 2011. Anthony has also worked in the Department of Justice's Office of International Affairs. He worked on international issues with various countries in Latin America and in the Counterespionage Section, where he investigated and prosecuted violations of the espionage statutes, atomic energy act, and export control statutes. Anthony worked as an assistant state's attorney in the Cook County State's Attorney's Office from 1998 to 2003. He received a BA from the University of Wyoming and his JD from the University of Wyoming College of Law.

**Jamie N. Jones**
*Director of Social Entrepreneurship*
*Clinical Assistant Professor of Entrepreneurial Practice*
*Kellogg School of Management at Northwestern University*

Jamie works with students, alumni, and members of the community to apply business principles for positive societal and/or environmental impact. Since starting at Kellogg, Jamie has launched the Morgan Stanley Sustainable Investing Challenge, co-hosted the Impact Investing Summit, and facilitated the creation of the NUvention Impact course. Jamie is also the cofounder of Impact Engine, a Chicago-based impact venture accelerator designed to support start-up entrepreneurs who have an integrated approach to financial returns and societal impact. Jamie earned an MBA from the Kellogg School of Management at Northwestern University. Prior to Kellogg, Jamie was a product development chemist in the private sector and worked in several areas, including medical devices and material science. She earned a PhD in chemistry from the University of Texas at Austin and a BS in chemistry from the University of Tennessee.

**Seth Kravitz**
*Cofounder*
*Technori and Bow Truss*

Seth is cofounder of Technori, a publication that celebrates entrepreneurship, and Bow Truss, a premium coffee roasting company. After falling in love with the Chicago entrepreneur community, Seth started mentoring at the Coleman Center at DePaul University, the Knapp Center at IIT, Excelerate Labs, and Code Academy. Seth started a web design firm out of his dorm room at Ohio State University when he was 19 before cofounding InsuranceAgents.com in 2004. The company grew to a 65-person operation and reached number 24 on the Inc. 500 before being acquired by Bankrate (NYSE: RATE) in 2012.

**Liam Krehbiel**
*Founder and CEO*
*A Better Chicago*

Liam Krehbiel is the founder and CEO of A Better Chicago, a nonprofit venture philanthropy fund launched in 2010. A Better Chicago provides funding and management support to a portfolio of high-performing nonprofits that are dramatically advancing opportunities for Chicago's low-income population. Prior to founding A Better Chicago, Liam spent 10 years working in the corporate and nonprofit sectors. Most recently, he was a management consultant at Bain & Company, where he worked on a variety of strategy and operational projects for Fortune 500 and mid-market clients. Prior to Bain, Liam worked at the Edna McConnell Clark Foundation, where he identified, assessed, funded, and supported a portfolio of high-performing youth development organizations that aspire to scale nationally. Earlier in his career, Liam worked in the investment banking group of William Blair & Company and in the development office of ACCION, a global microfinance organization. Liam serves on the boards of Big Shoulders Fund, the Chicago Public Library Foundation, and the Noble Network of Charter Schools. Liam has a BA in history from Dartmouth College and an MBA in finance and marketing from the Kellogg School of Management at Northwestern University.

**Nathan Laurell**
*Founder*
*New Frontier Holdings*

Nate is the founder of New Frontier Holdings, an investment firm focused on sustainable energy and agriculture; a cofounder of Energy.me, a retail energy supplier; and the founder and CEO of AMP Americas, a company that builds, owns, and operates sustainable infrastructure to create and supply renewable energy. Previously, he was a principal and director at Infinium Capital Management, a proprietary trading firm with offices in Chicago, New York, and London. He started his first company in college and has since been involved with a series of start-ups spanning the software, finance, and energy sectors. In addition, Nate is currently a partner and member of the Advisory Council of Acumen Fund, a patient-capital fund based in New York. He earned a BS and MS in electrical and computer engineering from the University of Illinois at Urbana-Champaign and completed the Chicago Management Institute's program at the University of Chicago's Booth School of Business and the Executive Seminar at the Aspen Institute.

**Emilia Lopez**
*Vice President, Strategy*
*CapitalOne*

Emilia Lopez is a vice president in the Strategy Group, based in the McLean, Virginia, office. The group supports Capital One's Lines of Business in critical strategic efforts. Prior to joining Capital One, Emilia was a principal with the Boston Consulting Group in Chicago. Emilia primarily worked with clients in the banking and payments sectors on growth strategies, innovation, and organizational topics. Prior to joining BCG, Emilia worked at Citibank for eight years, holding several positions mainly related to corporate credit and risk management. Emilia has an MBA from the University of Chicago Booth School and a bachelor's degree in business from C.E.S.A, Colombia.

**Amy Maglio**
*Founder and Executive Director*
*Women's Global Education Project*

Amy is the founder and executive director of Women's Global Education Project (WGEP) and the chief architect of WGEP's model for international development, a community-based approach for girls' education initiatives. In 2010 Amy presented WGEP's model as a "Best Practice" in girls' education at the UN Girls' Education Initiative Conference in Dakar, Senegal, and drafted the UN Declaration on Gender Equality. Also in 2010, WGEP was selected by Neutrogena to be the face of Girls' Education in the "Wave for Change" Campaign. Amy was a 2011 Impact Award winner from the Chicago Foundation for Women and is a regular guest on Chicago Public Radio. Amy holds an MA from the School of International Service at the American University in Washington, DC and a BA from the University of Massachusetts at Amherst. She began her career with the US Agency for International Development and served in the US Peace Corps.

**Jeff McCarter**
*Founder & Executive Director*
*Free Spirit Media*

Jeff McCarter is founder and executive director of Free Spirit Media, which he created to share his experience as a media professional (cameraman, editor, and Emmy Award–winning producer) with youth from under-resourced communities. In mainstream media, Jeff witnessed the lack of diversity in both representation and opportunity. Now, Free Spirit Media cultivates diverse youth voices to transform media and society. Jeff was a founding co-chair of the Chicago Youth Voices Network and serves on Chicago's Committee for Media Access. He is a thought leader in the fields of youth media education and digital media and learning and has presented at multiple conferences, including DML (Digital Media and Learning) and ACM (Alliance for Community Media). Jeff studied humanities and film production at the University of Colorado and Non-Profit Management at the University of Illinois at Chicago. He has worked on feature films directed by Steven Soderbergh and Ron Howard and on documentary television with ABC News, PBS, and WTTW Chicago. Jeff is a fellow of Leadership Greater Chicago and The Chicago Council on Global Affairs' Emerging Leaders Program and is a member of the Economic Club of Chicago. He lives with his family on Chicago's West Side. He also serves on the board of Friends of STEM Magnet Academy and the Douglas Park Advisory Council.

**Josh Milberg**
*Regional Vice President for Midwest Operations*
*Willdan Energy Solutions*

Josh is responsible for building the energy efficiency and smart grid practice in the Midwest and for providing strategic counsel to select clients. He has significant experience in strategy, finance, environmental policy, economics, and organizational development. From 2009 to 2011 Josh served as the first deputy commissioner of the Department of Environment for the City of Chicago. Josh is a recognized leader in the fields of sustainability, smart grid, and electric vehicle deployment strategies. Josh has spoken at many international conferences, including the UN Habitat World Urban Forum in 2011. He was appointed to serve on the Illinois Electric Vehicle Advisory Council by Governor Pat Quinn. He is also a founding board member of the Institute for Sustainable Energy Development, a think tank that supports the deployment of smart grid around the world. Josh graduated from Claremont McKenna College (cum laude) and received his MBA with concentrations in strategy and finance from the Yale School of Management.

**Caralynn Nowinski**
*Executive Director and CEO*
*UI LABS*

As executive director, CEO, and co-founder of UI LABS, Caralynn oversees the entire research and commercialization collaborative, including the $320-million Digital Manufacturing and Design Innovation Institute.

UI LABS brings industries, universities, and government together to apply real solutions to tomorrow's most important business, economic, and cultural challenges. UI LABS actively cultivates and channels talent and resources, fosters unbiased collaboration to bring new ideas to market, and drives economic growth and competitiveness. Prior to UI LABS, Caralynn was associate vice president for innovation and economic development at the University of Illinois. Caralynn spent her early career in venture capital and corporate finance, primarily focused on technology-based university spin-outs. She was a principal with early-stage venture capital firms ARCH Development Partners and Midwest Venture Partners and was senior vice president of Sikich Investment Banking. As a graduate student, she co-founded SanoGene Therapeutics, an early-stage biotechnology company, where, as CEO, she led the company's spin-out from the University of Illinois and raised a strategic equity investment. Caralynn is a governor-appointed member of the Illinois Innovation Council and currently serves as a member of Mayor Emanuel's ChicagoNEXT Council on Innovation and Technology. Among her honors, she was named to the *Crain's Chicago Business* 2008 "Forty Under Forty" list and is a member of The Chicago Council on Global Affairs Emerging Leaders Class of 2014. She is a frequent guest speaker on technology entrepreneurship and early stage investment.

**Rebecca Riebe**
*Global Technology Consultant*

Rebecca Riebe is a global technology professional currently consulting with Strategic Systems and Innovation at Hyatt Corporation. Rebecca spent the early part of her career in operations with Clark Material Handling, DHL, Procter & Gamble, Fritz Companies/UPS, and Dun & Bradstreet in the areas of data project management, customs brokerage, import/export regulation and global supply chain, global business development, and strategic market focus. Rebecca has managed international import operations for a national trade association, international taxation recovery processes for a global consultant, and global data integration and development projects in agriculture, food and drink, energy and environment, and the financial sectors. She has worked with many of the top Fortune 1000 companies in developing international trade, technological process efficiencies, and market opportunities. Prior to her current role she was director of global business initiatives at Global Midwest Alliance, and private-sector liaison officer to the World Bank. She held the position of vice consul for energy and environment at the British Consulate General in Chicago and was responsible for UK Trade & Investment's industry sector commercial relationships in energy and environment and the 2012 London Olympic Games. Rebecca holds BA and MA degrees from the University of St. Andrews in St. Andrews, Scotland, and master's certifications from the Illinois Institute of Technology in Chicago, Illinois.

**Justin Rose**
*Partner and Managing Director*
*The Boston Consulting Group*

Justin serves clients primarily in the industrial goods and energy industries. In addition to supporting his clients on a host of strategic and operational issues, he has also coauthored a number of high-profile reports, including the recent series "Made in America, Again," which focus on the return of manufacturing to the United States. Justin is the leader of BCG's alternative energy team in the Americas and led the development of the Department of Energy's "United States Strategic Technology Energy Plan," a roadmap to achieve an 83 percent reduction in carbon emissions for the US economy. While at BCG, Justin has been based for extended periods in Mexico, Thailand, and Japan. He holds a BS degree in mathematical methods in the social sciences and a BS in economics from Northwestern University, which he was awarded with honors, as well as an MBA from Northwestern's Kellogg School of Management.

**Nirav Shah**
*Associate*
*Sidley Austin, LLP*

Nirav is in Sidley Austin's Global Life Sciences practice and is a lecturer in the Department of Medicine at the University of Chicago, where he teaches courses in global public health and mathematical epidemiology. His law practice focuses on issues of fraud, abuse, and corruption in the health care system. Nirav previously served as chief economist of the Ministry of Health of Cambodia, during his tenure as a Henry Luce Scholar. In Cambodia he worked on a variety of public health programs aimed at reducing corruption in the health care system. In particular, he designed a system that reduced the number of administrative steps required to transfer funds from the central ministry to rural hospitals, thereby reducing opportunities for graft. Nirav holds an MD and a JD from the University of Chicago, where he won the Hinton Moot Court Championship. After graduating from college, he studied economics at Oxford University.

**Jacob Sitati**
*Managing Principal*
*Maurice and Fischer*

Jacob is cofounder of Maurice and Fischer, an international advocacy firm focused on public affairs, public policy, and market entry strategy. He directs overall firm business and is the lead counsel on policy and advocacy work for the firm. He previously served in various capacities in the legal field while working at various boutique labor and employment law firms and the insurance industry in Chicago and the greater metropolitan area. Prior to Maurice and Fischer, Jacob worked as a legal consultant for a leading insurance company in the government relations and public policy group. In addition to policy and advocacy work at Maurice and Fischer, Jacob is an adjunct faculty member and assistant professor at Valparaiso University; the executive director of Vision for Kenya, a nonprofit organization; and a President's Circle member at The Chicago Council on Global Affairs. Jacob has a background in economics, political science, information technology and privacy law, and international commerce and policy.

**Ted Souder**
*Head of Industry, Retail*
*Google*

A 12-plus-year veteran at Google, Ted is currently head of industry, retail, based in Google's Chicago office. In this role he manages a team that oversees the Google experience for some of the largest retail companies in the United States. Prior to his role in retail, Ted spent a year in Paris, where he oversaw key efforts in southern and eastern Europe, the Middle East, and Africa as the head of international strategic sales and operations. Ted also served as a regular industry speaker, employee mentor, and member of the executive management team for the SEEMEA region. Currently, Ted is actively involved in various civic and educational organizations, including the board of directors of the Chicagoland Chamber of Commerce and the executive advisory board of the Fritz Knoebel School of Hospitality Management at the University of Denver. He is a member of the strategy and planning committee of the Economic Club of Chicago, a member of the Expo Chicago Civic Committee, and is a President's Circle member of The Chicago Council on Global Affairs. Ted graduated from the University of Denver.

**Yves Thill**
*Principal*
*A.T. Kearney*

During his consulting career, Yves has had the opportunity to work for many leading companies across different industries on a variety of issues. More recently, Yves has been focused on supply management in the consumer goods and retailers industry, in particular in the food and beverage sector. Prior to joining A.T. Kearney, Yves worked in international banking in Europe. Born in Luxembourg and educated in Belgium, his career has taken him across both Europe and North America. He is fluent in several European languages, including French, German, and Luxembourgish. Yves has an MBA from the Ross Business School at the University of Michigan.

**Courtney A. Thompson**
*Director, Government Operations, Great Lakes Region*
*The Boeing Company*

Courtney is Boeing's government operations leader for the Great Lakes region, including Illinois, Indiana, Michigan, Minnesota, and Wisconsin. In this capacity she leads the company's community outreach efforts for the business, government, and international communities as well as Boeing's Chicago Global Corporate Citizenship team. Prior to this current position, Courtney was director of employee communications and the communications leader for the human resources and administration organizations. She joined Boeing's corporate communications team in May of 2002. Courtney currently serves on the boards of the Chicagoland Chamber of Commerce, Chicago Sister Cities International, the Gene Siskel Film Center, the Joffrey Ballet, and the Civic Federation. She received her BA from Providence College and an MBA from Northwestern University's Kellogg School of Management.

**Jennifer Thompson**
*Executive Vice President*
*Edelman*

As executive vice president and head of the Chicago Crisis & Risk Practice at Edelman, Jennifer develops strategy and mitigation solutions for corporate crisis and risk avoidance. Working with multinational clients to respond to situations and also proactively develop reputation management plans, Jennifer engages Edelman's global team to help guide the practice in the international realm. She led the on-site communications response team at Penn State University during its epic reputation crisis, and also served as Edelman's global client relationship manager for GE, coordinating every GE global work stream and delivering strategic counsel for its senior leadership. Previously, she was managing director of international operations at Oshkosh Corporation, heading global growth and marketing. For three years, she directed its Asia Pacific government relations activities from Beijing.

She got her start in government, serving as legislative director to a senior House Armed Services Committee member and has lived in China, Spain, and Japan during her career. A graduate of Northwestern University (BA, MBA) and the Naval War College (MA), she serves as an advisory board member of the Chicago Children's Advocacy Center and is a cellist in the Chicago Metropolitan Symphony Orchestra.

**Mark R. Williams**
*Managing Director*
*Huron Consulting*

Mark is a managing director at Huron Consulting and leads the Discovery Services Group comprised of multiple business units, data analytics, and nine review centers around the world, seating 1,500 attorneys. Prior to joining Huron, Mark served as senior vice president and member of Management/Planning Committee of Axiom Global, Inc. and as head of its Managed Discovery division, LawyerLink.

Prior to that, Mark was at the law firm of DLA Piper, where he was a partner in the corporate and finance group and hiring partner. During his 18 years at DLA Piper, Mark spent four years in China, where he was managing partner, and one year in Qatar, where he opened the Doha Office and was head of corporate. He was also one of the founders of an India-based legal process outsourcing business.

Mark holds a JD from Columbia University Law School, an MBA from the University of Maryland/Beijing University for International Business and Economics, an MSc in international relations from the London School of Economics and Political Science, and a BA in political science from the University of Illinois.

In addition to China and Qatar, Mark has lived and worked in England, Spain, South Africa (at the Legal Resources Centre, a human rights law firm), Korea (at the law firm of Lee & Ko), and Thailand (as a Henry Luce Foundation Scholar), and has traveled to over 150 countries.

# Emerging Leaders Class of 2014

**Kamran Bajwa**
*Kirkland & Ellis*

**Aileen Furlong Caffrey**
*United Airlines*

**Lincoln S. Ellis**
*Green Square Capital*

**Anthony P. Garcia**
*The Boeing Company*

**Jamie N. Jones**
*Kellogg School of Management at Northwestern University*

**Seth Kravitz**
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**Liam Krehbiel**
*A Better Chicago*

**Nathan Laurell**
*New Frontier Holdings*

**Emilia Lopez**
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*Women's Global Education Project*

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**Ted Souder**
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**Yves Thill**
*A.T. Kearney*

**Courtney A. Thompson**
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**Mark R. Williams**
*Huron Consulting*

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