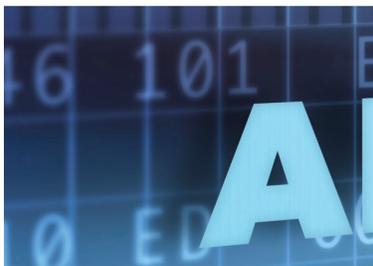




Smart City as a Service:
*Using Analytics to Equip Communities
for Data-Driven Decisions*



FROST & SULLIVAN

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Brian Cotton

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Regional and municipal governments and large public organizations are striving to deliver higher levels of service, but are challenged with flat or decreased funding to support their efforts. One solution is to use the vast stores of data available to gain a better perspective to identify opportunities to deliver services more efficiently, and engage stakeholders with open data initiatives to create innovative programs – in effect becoming a smart city. A framework approach to apply advanced analytics to these floods of data provides a roadmap to achieve these aims, but city IT organizations are often limited by staff size, skill and budget, and are unable to implement the framework on their own. Cloud computing and software as a service can provide the means to quickly acquire data-driven decision-making capabilities that support smart city initiatives, putting advanced services within reach of virtually any size city.

CHALLENGES MUNICIPAL OFFICIALS FACE DELIVERING SERVICES

From public safety, transportation, to water and energy utilities, to city planning, effective stewardship of natural and financial resources is critical to providing public services. Reducing waste and increasing efficiency in government operations to sustainably deliver improved citizen and business services is the heart of many local government agendas.

What to do with a Flood of Data

Public safety organizations, municipal administrations and public service departments, including transportation and municipally owned utilities, generate and consume a lot of data.¹ Local government amasses volumes of data on everything from public works, public safety and public facilities to elections, permitting and taxes. Every day, new data is created from across a city's infrastructure through sensors and video cameras, as well as from people interacting with the government and from mobile apps. Legislation mandating retention periods² guarantees that legacy data accumulates, and the mass is perpetually growing from new data that is continually arriving in structured and unstructured formats. Although this flood of data is challenging, there is ample opportunity to fundamentally change the way services are delivered.

Meeting the High Demand for Services and Providing a Better Experience on a Limited Budget

Public organizations and utilities are facing demands from citizens for more convenient access to services and expectations for a seamless, easy-to-use experience.³ This means less waiting in lines, problems fixed the right way the first time and less disruption from incessant construction on the streets. At the same time, government expenses – particularly at local levels – are increasing due to rising urbanization and aging infrastructure, as well as new program requirements passed down from national and regional governing bodies without sufficient funding to support them.⁴ This conundrum puts a premium on finding innovative ways to increase the value of government on a limited budget.

Government can solve this conundrum by digging deep into the data that it already has and surfacing connections and insights into how city goals and work projects are interrelated. Improved analytics can help city leaders and public officials better predict what can happen in the future, as well as guide their activities to achieve optimal outcomes for citizens. When analytic tools are shared, department managers can work across administrative boundaries and organizational silos, and collaborate around integrated service delivery models.⁵ Thus, distinct departments and agencies can see where activities can be mutually supportive (e.g., excavating the streets once to repair water mains, identifying areas where crime is a problem, resurfacing streets and replacing outmoded street lights) and operate from a common, single view of the city so that work is done more efficiently and more

effectively. At the municipal level, this kind of collaborative approach can direct budget savings to new service initiatives and enable the city to be managed as a coordinated, holistic system of systems. This is the foundation for a city to become a smart city.



Many forward-looking organizations seeking to implement their smart city vision are now considering cloud computing as a way to quickly obtain powerful insight capabilities without committing to large capital expenditures.



Making it Happen

Gaining deeper insight involves gathering all available data, organizing it, and then performing several types of analysis on it. However, most municipal governments have insufficient staff or skill to devote to this effort. Given constant demands placed on already limited budgets, city leaders need to acquire these capabilities quickly, with low upfront investment. This isn't restricted to the local level; individual departments, such as water or transportation, or state and provincial levels facing floods of data will also seek to acquire capabilities quickly and cost-effectively.

Many forward-looking organizations seeking to implement their smart city vision are now considering cloud computing as a way to quickly obtain powerful analytic capabilities without committing to large capital expenditures. Rather than investing in city-owned and operated analytic tools, another option is to consider analytics offered as a service. City IT managers can determine if implementing smart city as a service is the right approach for their city by understanding the main types of analytics a smart city uses and the value they deliver.

ANALYTICS APPLIED TO CITY PROBLEMS

Business intelligence and analytics have a strong foothold in modern government.⁶ In public safety, for instance, data mining and analytics are helping to shift crime fighting work from reactive to predictive and preventative modes in cities such as Vancouver, Memphis and London. The use of analytics in other domains, such as education, water and public transportation, illustrate how cities are integrating analytic capabilities into many domains to solve problems confronting them.⁷ The resulting benefits include improved program success, cost savings and higher levels of services for citizens. Municipal governments seeking to generate value from their data will use analytics to learn from the past, look into the future, guide policy and activity to obtain optimal outcomes, and understand relationships between events and locations.

Geospatial Analytics: Understanding Where Things Happen

Geospatial analytics allow city managers, agency operations staff and other stakeholders to visualize events and conditions as they happen in specific places and how they may change over time. Geospatial techniques are often used with other types of analytics to enable users to associate cause and effect relationships with specific places under their jurisdiction. Geospatial analytics can produce density and heat maps, time-distance relationships and group optimization that can assist city and departmental officials allocate resources, plan for zoning or

temporary events, or understand population movement. Moreover, combining geospatial analytics with other types of analytics can enable cities to choose optimal routing for new roads or pipelines, siting fleet maintenance facilities or selecting community healthcare locations.

Descriptive Analytics: Learning from the Past

Descriptive analytics provide city leaders and departmental managers situational awareness and an understanding of historic trends. This could cover, for instance, establishing baseline departmental budgetary performance and the achievement indicator of each department, the frequency and nature of inquiries or complaints registered and response time to address them, and the current operational readiness of a city's fleet of road maintenance vehicles. Descriptive analytics can also enable program administrators to quickly determine eligibility for benefit programs and match the right services to citizen needs, prevent fraud and waste of funds, as well as be used for planning purposes.

Philadelphia, for instance, uses descriptive analytics to identify tax delinquent properties that are available for auction.⁸ A property in Philadelphia is considered delinquent if taxes owed are not paid within nine months of the city's deadline. These properties are subject to interest and other fees, which can accumulate and eventually overwhelm the value of the original tax. Often these properties are abandoned, creating a growing backlog of delinquent properties that can linger for decades. The city publishes an interactive map showing these properties, with which prospective buyers can easily identify opportunities. Interested buyers use the results of descriptive analytics to find investment opportunities, which can become revenue opportunities for the city.

Predictive Analytics: Transitioning from Reactive to Proactive

Predictive analytics develop insight into possible future conditions or events within a city or region, probable impacts of programs and policies, and potential citizen or business reaction to new initiatives. Predictive analytics measure the efficacy of services delivered, which can help fine-tune programs. Predictive analytics can also help city managers and officials test scenarios, for instance during emergency conditions or extreme weather events, and develop contingency plans to enact should any of these scenarios become realized. Predictive analytics can also help agencies identify risks associated with new initiatives, streamline the delivery of services and prevent duplication or fraud in the system for current initiatives.

Chicago is one example of a city using descriptive analytics to solve problems. Chicago, like other cities, constantly battles rat infestations. Using citizen complaints to its 311 non-emergency services line, Chicago's Department of Streets and Sanitation developed models that can predict where rat populations are high, such as where garbage accumulates, and when rat populations are likely to increase quickly.⁹ By combining the predictive models with geospatial analysis, pest control officers can have a visual representation to indicate the times and places where their efforts can be most effective.

Prescriptive Analytics: Make Things Happen

Based on an understanding of how systems have behaved in the past, and how they are likely to behave in the future in a variety of circumstances, prescriptive analytics not only enable insight into the likely results of decisions, but also suggest the optimal path to achieve desired outcomes. They can be applied to determine the best way for a municipal program to achieve its policy goals, for instance. Prescriptive analytics can also support informed decision-making around developing new service delivery programs, providing personalized services to specific segments of a city's population, or to optimize the use of limited city resources and assets.

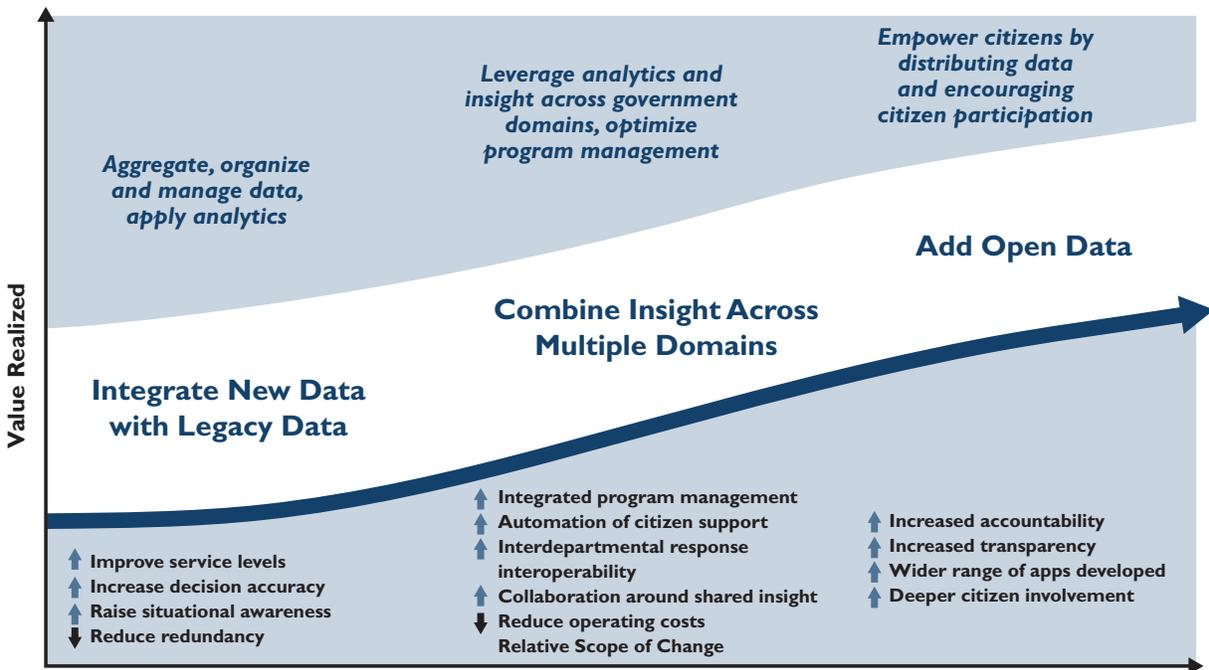
Prescriptive analytics are relative newcomers to municipal government implementations, but one example is found in the City of Des Moines, Iowa's Wastewater Reclamation Authority (WRA). The WRA uses predictive analytics to optimize the operation of the motors in the city's treatment plants.¹⁰ By understanding the performance cycles on the motors, the WRA was able to design operational and maintenance schedules that lower energy usage by 20%, helping make better use of the WRA's budget.

UNLOCK THE VALUE OF DATA TO DELIVER BETTER SERVICES, FASTER

The data a municipal government has from which to generate analytics can come from legacy systems, devices and from people. Once city leaders understand how analytics can unlock the value in this data and envision how analytics can help deliver higher levels of service and optimize lean budgets, the next step is to map out implementation goals and plans that will drive their smart city transformation. Municipal planners and CIOs can use a framework approach, depicted in Figure 1, as a guide.

The framework approach in Figure 1 recommends three methods that create increasingly more value from the application of data analytics. Starting from a single domain or department, the approach can be extended to include other stakeholders, including citizens and businesses, and then to other domains across the municipal government. A municipal CIO or IT manager can also implement all three methods concurrently. As the relative scope of change associated with each method increases, the amount of value realized in making a city smarter increases.

Figure 1: Three Methods to Unlock the Value of Municipal Data



Source: Frost & Sullivan

Integrate Existing Data with New Sources of Data and Apply Analytics

A city's CIO or departmental IT manager will prepare for data-driven decision-making by making all municipal available data consumable by analytic tools, and then integrating it. This involves aggregating and organizing the data, and understanding the relationship between different types of data. Legacy system data, for instance, is static and structured, often housed in different storage locations. Other data is from a multitude of sensors placed around the municipal infrastructure, as well as from surveillance cameras located around the city. Increasingly, newer forms of data are generated by people – from interactions with 311 services, smartphones or monitoring social media – and these also need to be integrated. Once the data is integrated, different types of analytics can be applied.

Immediate value can be realized through reducing or eliminating redundant data in the system. At the same time, the results of analysis can help municipal officials and department heads improve service levels, increase the accuracy of their decisions and raise their overall situational awareness across the city. The framework approach recommends starting small with a single department or domain to gain experience with implementing analytics, and achieve some successes that can be used to promote the approach to other departments.

Deliver Transformative Insights: Combine Insight Across Domains

The hallmark of collaborative, integrated service delivery models is breaking down traditional silos and integrating key functions across domains to encourage collaboration between them. Once a municipal CIO or IT manager prepares the data and applies analytics in one department, the approach can be extended to other departments. The goal is to create shared insights across domains, thereby achieving higher value for municipal and department decision-makers that transcend individual domains.

Combining insight across domains gives departmental users the capacity to make associations between formerly siloed facts and events, people and trends. By using this approach, a department can identify new or previously unknown issues, root causes of problems, or affect a new policy. Government itself will realize value from a broad application of the approach when departments collaborate around shared data, and interoperate more easily through a common understanding of a situation and follow a collective response plan. Moreover, government can integrate and optimize program management, reducing operating costs and making the most of available resources.

Increasing Value with Open Data

The value of shared insight can be increased when municipal data is published in open formats, within accepted security limits, to the public. This is Open Data, and granting citizens, businesses and institutions access to municipal data amortizes the value of the data management and analytic tool investments. New value is created when third parties develop new applications and services to address public and private needs, which extend beyond governments' capacity. Open data empowers citizens and encourages deeper participation, and it encourages large and small businesses to innovate through new applications and services. Many governments, such as Canada¹¹, recognize increased citizen engagement under these programs and are actively expanding them to encourage participation in policymaking and regulatory processes.

Open Data increases government accountability and transparency. Mitigating concerns that staff in government offices may have over potentially increased workloads caused by citizen complaints requires leadership and vision to demonstrate that increased transparency will, in the long run, improve citizen satisfaction and lower complaints. One department's move to open data can serve as a role model of positive change, guiding other departments' transition to Open Data.

CLOUD COMPUTING ENABLES SMART CITY AS A SERVICE

All the tools and enablers that support data-based decision-making in a smart city magnify the flood of data challenges confronting municipal IT departments. Analytics, collaboration and Open Data can place substantial storage burdens on municipal IT systems. This is loud and clear in a recent survey we conducted in which 33% of government IT managers in the US cite “data storage growth” as their top IT challenge.¹² Compounding the problem, the always-on, 24x7 expectations of government service availability means that IT managers need a sophisticated backup strategy, which may also need to comply with strict measures on the duration and means of storage.

With the exponential growth in the amount and type of data, as well as the additional computing resources required by analytic-based decision tools, municipal IT departments will struggle to continually invest to maintain a traditional, largely inflexible, on-prem infrastructure to support these workloads. What municipal IT departments need is a new way to procure IT resources that can supplement current systems; one that enables the mayor, city council and departments to engage in data-driven decision-making and transition their city into a Smart City. Cloud computing is that new way.

Government has adopted cloud less quickly than other industries. Security and compliance concerns have historically been the main reasons keeping governments from being early adopters. However, this is changing as cloud service providers focus more on security and compliance issues, including in some cases offering government-certified versions of their services. As a result, government IT departments are increasing their use of cloud services. In fact, a recent Frost & Sullivan survey found that 37% of regional and local government IT managers in the US and Europe are currently using cloud computing, including software as a service (SaaS), while 57% are expected to be using it by 2016.¹³

The Tactical Benefits of Using Cloud to Enable Data-Driven Decision-Making

The key drivers for increased government adoption of cloud are the tactical benefits of shortening the time to value through rapid deployment, and making IT costs more “budget-friendly.” This combination of benefits enables departments to quickly prove the value of cloud-based analytics, which can drive support for expanding the deployment of cloud-based analytics to other departments. Rather than trying to obtain a rigid capital budget to implement storage, collaboration and analytic tools on a traditional, on-prem infrastructure, IT managers can procure these tools through the cloud using a more flexible operating budget. This is supported by our survey data that shows fully 50% of government IT managers cite “shifting costs from capital to operating budget” as a “very important” reason to procure IT services through the cloud.¹⁴

In addition, IT managers can match planned growth of smart city services (e.g., water, public safety, traffic) or additional users to operational budgets so the cost keeps pace with actual needs and available resources. A further tactical benefit of cloud is that there is a much lower management burden on a municipal IT staff to support the advanced analytics capabilities that underlie many smart city services.

The Strategic Benefits of Using Cloud to Enable Data-Driven Decision-Making

Most organizations, including government, start with the tactical benefits of cloud but soon shift to more strategic considerations that underpin a deeper transformation of overall IT operations to align with changing business goals. A powerful and open cloud platform enables municipal CIOs and IT managers to build a flexible foundation to support a comprehensive smart city service strategy that can grow to support future needs. Another benefit of a cloud strategy is that it gives IT managers an option to deploy on a hybrid cloud model, so workloads can be deployed on traditional platforms, cloud, infrastructure or software as a service, depending on the cost, performance and security needs for each workload.

Mayors and department heads will also find strategic benefits from a cloud-based implementation of smart city services. Analytic and collaboration capabilities, and the smart city services that rely on them, can be rolled out quickly and scaled up as citizens increase their usage of the services. Moreover, cloud supports high levels of service resilience, so critical smart city services are always available, no matter the time or location in which they are needed. Finally, municipal CIOs can optimize costs because the entire environment can be managed from a single console, simplifying their administrative workload and maximizing infrastructure flexibility.

EQUIPPED TO MAKE DATA-DRIVEN DECISIONS: SMART CITY AS A SERVICE

Citizens and stakeholders are demanding higher levels of service from government and municipally owned organizations. City leaders and department heads are applying descriptive, predictive, prescriptive and geospatial analytics to municipal data to make better informed decisions. By integrating all available data and applying analytics to it, municipal CIOs and IT managers are equipping their cities to make data-driven decisions – and this value increases when multiple departments and citizens themselves are able to collaborate around these capabilities. Philadelphia, Chicago and Des Moines are demonstrating that data-driven decision-making is a wise path to become a Smart City and meet demands for higher levels of service.

Although the analytic and collaboration capabilities that support data-driven decision-making can be implemented on a municipal or department computing platform, many cities do not have the personnel or skill to do this. Instead, CIOs and IT managers can obtain these capabilities as a service through a cloud platform and maintain the flexibility to grow data-driven decision-making capabilities as needs and resources allow. Moreover, by implementing a smart city strategy on cloud, municipal IT managers gain the freedom to support the mayor's policy goals and departmental needs in a variety of ways. With these capabilities available as a service, virtually any city can easily, cost-effectively and quickly evolve into a Smart City.

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ENDNOTES

1. "The Open Society." *The Economist*, 25 February 2010 edition. <http://www.economist.com/node/15557477>. Retrieved 13 November 2014.
2. State of California, Archives Division. "Local Government Records Management Guidelines." February 2006. <http://www.sos.ca.gov/archives/local-gov-program/pdf/records-management-8.pdf>. Retrieved 12 November 2014.
3. Fruechting, Ashley. "The Digital Town Hall: Meeting Citizen Expectations through Government Websites." *Canadian Government Executive*, Volume 20, Issue 8. 03 November 2014. <http://www.canadiangovernmentexecutive.ca/category/item/1675-the-digital-town-hall-meeting-citizen-expectations-through-government-websites.html>. Retrieved 05 November 2014.
4. *Ibid.*
5. Janowski, Tomasz and Ojo, Adegboyega. "Transforming Government through Knowledge Management and Communities of Practice." United Nations University, Center for Electronic Governance. Presentation proceedings from the China E-Government Forum 2009, 16-17 April 2009. www.egov.iist.unu.edu. Retrieved 11 May 2012.
6. Levine, E.S. "Challenges for Public Sector Analytics." *Analytics Magazine*, March/April 2012. www.analytics-magazine.org/march-april-2012/537-challenges-for-public-sector-analytics. Retrieved 20 November 2014.
7. Cotton, Brian. "Smarter Analytics for Government: The Importance of Infrastructure for Insight." A Frost & Sullivan White Paper. January 2013. <http://public.dhe.ibm.com/common/ssi/ecm/en/xbl03024usen/XBL03024USEN.PDF>. Retrieved 18 November 2014.
8. Tax Delinquent Properties in Philadelphia. http://www.philly.com/philly/news/special_packages/inquirer/in_HT_tax_delinquency.html. Retrieved 17 December 2014.
9. Thornton, Sean. "Using Predictive Analytics to Combat Rodents in Chicago." *Data Smart City Solutions*, July 12, 2013. <http://datasmart.ash.harvard.edu/news/article/using-predictive-analytics-to-combat-rodents-in-chicago-271>. Retrieved 17 December 2014.
10. Goldsmith, Stephen. "3 Ways to Optimize Urban Infrastructure." *Government Technology*, February 24, 2014. <http://www.govtech.com/data/3-Ways-to-Optimize-Urban-Infrastructure.html>. Retrieved 17 December 2014.
11. Boyle, Jim. "Stop, Collaborate and Listen: An Assessment of Canada's Open Dialogue Implementation Strategy." *Dalhousie Journal of Interdisciplinary Management*, Volume .10, Number 1 – Spring 2013.
12. Frost & Sullivan. "2014 Cloud User Survey." Unpublished survey data collected in 2Q2014.
13. Frost & Sullivan. "The Impact of IT in Government: An End-User Perspective." Report NDIE-72. July 2014.
14. *Op cit.* Frost & Sullivan 2014 Cloud User Survey.

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331 E. Evelyn Ave., Suite 100
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Fax 650.475.1570

San Antonio

7550 West Interstate 10,
Suite 400
San Antonio, TX 78229
Tel 210.348.1000
Fax 210.348.1003

London

4 Grosvenor Gardens
London SW1W 0DH
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877.GoFrost
myfrost@frost.com
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