Strategic Use of Analytics in Government

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Managing for Performance and Results Series

IBM Center for
The Business of Government

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T A B L E   O F   C O N T E N T S

F O R E W O R D

On behalf of the IBM Center for The Business of Government, we are pleased to present this report, "Strategic Use of Analytics in Government" by Thomas H. Davenport, President's Chair in Information Technology and Management at Babson College, and Sirkka L. Jarvenpaa, James Bayless/ Rauscher Pierce Refsnes Chair in Business Administration, University of Texas at Austin.

Governments use analytics (often described as "business intelligence") to enable and drive their strategies and performance in an ever more volatile and turbulent environment. Analytics and fact-based decision making can make a powerful contribution to the achievement of government missions, just as they are now making to the accomplishment of corporate business objectives.

Albert Morales

In their report, Professors Davenport and Jarvenpaa explore several important applications of analytics in government agencies and develop an assessment framework for those that either have not yet embarked on the analytics journey or are still in the early stages. The report focuses on four governmental mission and management areas—health care, logistics, revenue management, and intelligence—to which analytics has been applied.

While the opportunities from analytics for improving efficiency and effectiveness in government appear limitless, there is much less clarity about the readiness of government to embrace analytics. While analytics is often depicted as a technological innovation, Davenport and Jarvenpaa are careful to point out that the use of analytics requires managerial innovation.

Toni Yowell

Tom Davenport is at the forefront of research and thought leadership on issues confronting the information workers of tomorrow. His 2007 book, *Competing on Analytics*, has won wide acclaim. We hope that this timely and informative report will be useful to public executives at all levels of government.

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EXECUTIVE SUMMARY

In recent years, breakthroughs in data-capturing technologies, data standards, data storage, and modeling and optimization sciences have created opportunities for large-scale analytics programs. Several organizations in the private sector have not only leveraged fact-based decision making, but also created sustained competitive advantage from data-based analytics. They have built their business strategies—at least in part—around their analytical capabilities.

While government organizations and agencies don't necessarily compete with one another, they use analytics to enable and drive their strategies and performance in an ever more volatile and turbulent environment. Analytics and fact-based decision making can make just as much or even more of a powerful contribution to the achievement of governmental missions as they can to the accomplishment of corporate business objectives.

In this report, we explore several important applications of analytics in governmental agencies and attempt to develop an assessment framework for those that are yet to embark on the analytics journey or are still in the early stages of it. We focus specifically on four governmental areas: health care, logistics, revenue management, and briefly (because of the paucity of public sources) intelligence. The four sections identify governmental organizations that are exploiting analytics to meet their strategic goals. After the description of these activities and, in some cases, their impact, we discuss key factors that the agencies have faced in implementing analytics and relate them to our analytical capability assessment framework. We ground this framework in the strategic management literature, specifically the dynamic capabilities literature.

While the opportunities from analytics for improving efficiency and effectiveness in government appear limitless, there is much less clarity about the readiness of the government sector to embrace the opportunities. Whereas analytics is largely depicted as a technological innovation (often described as "business intelligence"), the strategic use of analytics in both the private and government sectors also requires massive managerial innovation. On the whole, while we found many examples of the successful use of analytics in government, we did not find the elements of leadership, an enterprise orientation, and long-term strategic targeting that would characterize both managerial innovation in general and a strategic focus on analytics in particular. That is, the applications of analytics we discovered were more tactical than strategic in nature, albeit important to the successful operations of the organizations employing them.

The Strategic Use of Analytics

In recent years, breakthroughs in data-capturing technologies, data standards, data storage, and modeling and optimization sciences have created opportunities for large-scale analytics programs. Several organizations in the private sector have not only leveraged fact-based decision making, but also created sustained competitive advantage from data-based analytics. These organizations make extensive use of sophisticated analytics, including forecasting and predictive models, simulation, and optimization. They employ these tools first deeply within a particular business domain and then broadly across the organization.

For example, the gaming firm Harrah's has chosen to compete on analytics for customer loyalty and service, rather than on building the mega-casinos in which its competitors have invested. Online retailer Amazon.com uses extensive analytics to predict what products will be successful and to wring every bit of efficiency out of its supply chain. Progressive Insurance has become a major competitor in the automobile insurance industry based largely on its analytical prowess around the pricing of risk. Professional sports teams such as the Oakland A's, Boston Red Sox, New England Patriots, and AC Milan soccer team employ analytics to maximize the quality and effectiveness of their players. These organizations, and a variety of others, have clearly changed the way they compete; they have transformed their core capabilities by investing in analytics.[1]

In brief, analytics is the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions. A fuller discussion of the concept of analytics is presented in the box on page 7.

Strategic Analytics in Government

Government organizations and agencies don't necessarily compete, but they use analytics to enable and drive their strategies and performance in increasingly volatile and turbulent environments. Analytics and fact-based decision making can have just as much or even more of a powerful effect on governmental missions as on corporate business objectives. The actual use of analytics in government can be either strategic—supporting or even driving the accomplishment of key missions and objectives—or tactical. Discovering just how strategically important analytics is to government missions was a key objective of this research.

There are already notable examples of the strategic application of analytics in crime prevention, including the CompStat program in New York[2] and the CLEAR program in Chicago, both of which use geographical data on crimes to drive placement of officers and other resources. The CompStat movement has been generalized to other urban performance management functions, including public education in Philadelphia[3] and overall city management in Baltimore.[4] This model is well documented and understood, so it is not the primary focus of our report. Instead, we focus on the ability of government to apply analytics to business practices in several other domains. As with these crime prevention and city management initiatives, however, we focus on government use of analytics that is strategic, that is, closely aligned to the strategy and mission of the government agency or organization.

While the opportunities from analytics for improving efficiency and effectiveness appear limitless, there is much less clarity about the readiness of the

government sector to do so. Whereas analytics is largely depicted as a technological innovation (often described as "business intelligence"), the strategic use of analytics in both the private and government sectors also requires massive managerial innovation. On the whole, while we found many examples of the successful use of analytics, we did not find the elements of leadership, an enterprise orientation, and long-term strategic targeting that would characterize both managerial innovation in general and a strategic focus on analytics in particular.

In this report, we explore the successes of analytics in governmental agencies and attempt to develop an assessment framework for those that are yet to embark on the analytics journey or are still in the early stages of it. We focus in particular on four governmental areas: health care, logistics, revenue management, and briefly (because of the paucity of public sources) intelligence. While there are certainly other domains of government in which analytics can be applied, these four certainly provide an overview of the issues involved in their application. The four sections identify governmental organizations that are exploiting analytics to meet their strategic goals. After the description of these activities and, in some cases, their impact, we discuss key factors that the agencies have faced in implementing analytics. We discuss each agency in terms of the key components necessary for leveraging analytics in our assessment framework. We ground this

framework in the strategic management literature, specifically the dynamic capabilities literature.

To develop this report, we relied on secondary literature (on both business intelligence and "the business of government") to identify agencies or external suppliers to government agencies as adopters of analytics within the four areas of health care, supply chain, revenue management, and intelligence. We identified a person in charge of either an analytical group or a key consultant to that group, and conducted a semi-structured telephone interview with that individual. In several instances, the person invited two or three others from the organization to participate in the conference call in order to provide a more accurate and broader description of the analytics activities. In a few cases where analytical activities were well documented in the secondary literature, we relied solely on those accounts. We primarily focus on analytics in the U.S. government, but occasionally address examples and findings in other countries where we could find them.

What Is Analytics?

From *Competing on Analytics: The New Science of Winning* by Thomas H. Davenport and Jeanne G. Harris
(Boston: Harvard Business School Press, 2007)

By analytics we mean the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions. The analytics may be input for human decisions or may drive fully automated decisions. Analytics is a subset of what has come to be called *business intelligence*: a set of technologies and processes that use data to understand and analyze business performance….

In principle, analytics could be performed using paper, pencil, and perhaps a slide rule, but any sane person using analytics today would employ information technology. The range of analytical software goes from relatively simple statistical and optimization tools in spreadsheets (Excel being the primary example, of course), to statistical software packages (e.g., Minitab), to complex business intelligence suites (SAS, Cognos, Business Objects), predictive industry applications (Fair Isaac), and the reporting and analytical modules of major enterprise systems (SAP and Oracle).
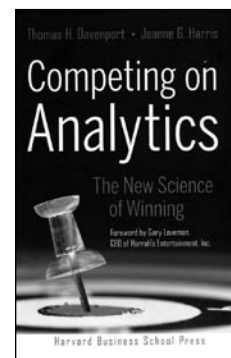
Concepts, Methods, and Tools for the Strategic Use of Analytics

The existing literature on strategic orientations to analytics in the private sector emphasizes several factors that are almost always present in analytical competitors. Having a strong analytical orientation would seem to be a function of data and information technology (IT), and indeed those resources are critical for analytical success. However, the necessary IT tools, both hardware and software, are widely available in the marketplace. The requisite data may be more difficult to capture and manage, although private sector firms are increasingly able to mobilize it given their investments in enterprise software, point-of-sale systems, and electronic commerce. Providing data for analytical applications means that it must be of high quality, separated from transaction systems in a data warehouse or single-purpose "mart," and consistent throughout the organization. The most successful analytical competitors also uncover data sources that are new for their industry; Progressive Insurance, for example, pioneered the use of credit scores for pricing automobile insurance.

A second attribute is that the firm takes an enterprise-wide approach to managing information and analytics. An organization may begin by working with particular business problems or functions, but their usage rapidly becomes cross-functional. It is usually necessary to take an enterprise perspective to pull together the expertise, data, and systems that allow the optimization of organizational relationships and resources.

Analytically focused organizations apply analytics to a clear strategic target or intent that they are attempting to optimize over time. The target may be based upon strong customer relationships and loyalty; highly efficient supply chain management;

precise risk and asset management; or even hiring, motivating, and managing high-quality human resources. In the private sector, the implementation of analytical strategy has required a long, often arduous journey. For example, the Barclay's UK Consumer Cards and Loans business took more than five years to implement its "Information-Based Customer Strategy," undertaking techno-logical, process, and organizational tasks to exploit analytics in its credit card and other financial businesses.[5]

Analytical competitors also have strong human analytical capabilities at the leadership and analyst level. They have senior executive teams that are fully committed to analytical strategies and capa-bilities. They also have a cadre of analytical profes-sionals who can both perform the needed analyses and work closely with decision makers to interpret and refine the analytical models.

What is not widely available in either the public or private sectors of the economy is the human dimension of analytical competition: leadership, disciplined management, and deep analytical expertise. It is these human attributes that truly differentiate successful analytical competitors. We therefore argue that managerial innovation[6] is a better approach to establishing strategic analytical capabilities than technological innovation.

There are now a variety of analytical applications, or tools, which can be grouped under the term ana-lytics. Some of these applications are used for inter-nal analytics (financial, research and development, human resources) and some for external analytics (customers, suppliers). The box on page 9 describes some of the best known analytical applications that

are now either in use by government or could be used by government in applying analytics to analyzing the activities and programs of government.

A Model for Assessing Analytical Capability

We can summarize these traits in an easy-to-remember acronym—called the DELTA model—that can serve as the beginning of an assessment approach (see Figure 1).

How do these traits apply overall to the public sector? We believe that most, if not all, are equally relevant to governments and private firms, but there are some obvious differences in how they are assessed and applied. The data, enterprise, and leadership factors are certainly relevant, and apply with minor changes.

Data: Governments often have privileged access to *data*, for example, though there may be greater restrictions on the security and privacy of the data. Government organizations, however, need to not only capture and "warehouse" the data, but analyze it. In the revenue management area, many states have not gone beyond data warehousing. While most of the states use commercial data management software, Colorado's Department of Revenue built its own in-house warehouse and data mining applications.[7]

Enterprise: An *enterprise* approach to analytics may be equally applicable, since government organizations also need to work across functions in order to present a unified face to citizens and constituents.

Figure 1: DELTA Model for Assessing Analytical Capability

D — Accessible, high-quality **data**

E — An **enterprise** orientation

L — Analytical **leadership**

T — A long-term strategic **target**

A — A cadre of **analysts**

Despite the need for an enterprise-based approach, we found that the fragmented nature of many government organizations is a hindrance to effectively using analytics.

Leadership: *Leadership* is also critical in making analytics a strategic focus within government organizations, though we found fewer analytical leaders than in the private sector. Governmental leaders do not, as a group, seem to have recognized analytical capabilities as a route to meeting their strategic goals. There are a few examples of this leadership orientation in U.S. government, such as Robert McNamara, former secretary of defense in the Kennedy administration.

Typical Analytical Applications for Internal Processes
From Davenport and Harris

Activity-based costing (ABC): The first step in activity-based management is to allocate costs accurately to aspects of the business such as customers, processes, or distribution channels; models incorporating activities, materials, resources, and product-offering components then allow optimization based on cost and prediction of capacity needs.

Monte Carlo simulation: A computerized technique used to assess the probability of certain outcomes or risks by mathematically modeling a hypothetical event over multiple trials and comparing the outcome with predefined probability distributions.

Multiple-regression analysis: A statistical technique whereby the influence of a set of independent variables on a single dependent variable is determined.

Target: We also believe that a long-term strategic *target* is critical in the government sector, although we didn't find it to be common in the agencies we researched. Strategic intent begins with a broad, sweeping goal that exceeds the agency's present grasp and existing resources.[8] It's often difficult in government to secure the long-term funding to press toward a strategic target. Our interviews with individuals in revenue and tax agencies revealed there is seldom the commitment and resource base to make the necessary investments unless the constituency base or the agency at large faces a major challenge, due to factors unrelated to investments in analytics. As a result, long-term strategic objectives in government must usually be achieved through a series of self-funding initiatives.

However, those who embark on an analytics-focused strategy need to devise a clear and compelling strategic target. This is in stark contrast to the project goals of many of the current analytics projects that focus on the operational level, such as dollars assessed or recovered per audit hour. These short-term goals may well be realizable in an overall analytical strategy, but they should not be the only objectives, as they are in many government environments.

Analysts: Finally, *analysts* are equally critical to private sector and government organizations, but it may be difficult for government organizations to hire and continue to employ high-quality analysts. Some government organizations have looked externally for analytical talent—for example, to federally funded research and development centers (FFRDCs) such as the RAND Corporation for military supply chain analysis, and to MITRE Corporation for intelligence analysis.

However the necessary resources are procured, analytics strategy should be seen as a key engine of a dynamic capability of the firm. Dynamic capabilities allow organizations in fast-changing environments to integrate, build, and reconfigure their internal and external capabilities.[9] Although the concept of dynamic capabilities is often applied in the private sector, it is increasingly relevant in executing government functions and delivering government services.[10] For example, revenue and tax agencies face increasingly dynamic flows of tax revenues; health care agencies face the prospect of aging baby-boomers and possible health care reform.

Analytics in Government Health Care

Analytics is increasingly important in health care, and in virtually every society around the globe, health care is—in part or in whole—a government responsibility. Even in the United States, where payment for health care is largely privatized, government paid 40 percent of the $2 trillion spent on health care in 2005. Whether the providers and payors of health care are public or private, analytics is key to health care performance across at least three domains: evidence-based medicine, payment fraud reduction, and the identification of patients for disease management.

In the United States, the two biggest government health care programs are Medicare (administered by the federal government) and Medicaid (administered by states). The Department of Veterans Affairs (VA) also has a large health care program, the Veterans Health Administration (VHA). All three health care programs are increasingly focused on analytics. Medicare is perhaps an exemplar of disease management, while the states have taken the lead in Medicaid fraud reduction. The VHA is one of the leading health care provider organizations in the use of evidence-based medicine.

Evidence-Based Medicine

Evidence-based medicine (also known as evidence-based practice) is simply the use of the best-available evidence from clinical research studies to guide the diagnosis and treatment of patients for specific medical problems. This approach may seem obvious, but physicians do not often consult evidence in making medical decisions; one study found they relied on their own memory or intuition in 70 percent of patient consultations.[11] A RAND Corporation study found that Americans receive appropriate care from their doctors only about half of the time, resulting in 98,000 annual deaths from medical errors, and another 126,000 deaths from physician failures to observe evidence-based care protocols for four common conditions: hypertension, heart attacks, pneumonia, and colorectal cancer.[12]

In some institutions, guidelines from evidence-based medicine are incorporated into online health care protocols to be followed by medical practitioners in treating patients; in other cases, the practitioner is presumed to consult online or print-based reference sources (though given the above study, this may be a dubious assumption).

The U.S. federal government has played a role in both aggregating and publishing evidence-based practice guidelines, and in applying them in its clinical practices. In the Department of Health and Human Services, the Agency for Healthcare Research and Quality (AHRQ) attempts to collect and distribute evidence-based practices in a variety of medical domains. AHRQ evidence reports synthesize and summarize the published evidence for or against the use of methods of testing, diagnosing, treating, managing, or preventing diseases. The agency commissions research to 14 Evidence-Based Practice Centers at medical centers based at universities and research institutes in the United States and Canada.

The VHA hospital organization is one of the primary practitioners of evidence-based medicine in the United States, and has pursued it along several different dimensions, which has led to a high level of care quality and performance. The VHA's approach has a number of components:

- An *electronic health record system* called VistA (Veterans Health Information Systems & Technology Architecture). According to one source, "The venerable Institute of Medicine notes that the VHA's 'integrated health information system, including its framework for using performance measures to improve quality, is considered one of the best in the nation.'"[13] VistA also includes online care protocols and safeguards against inappropriate drug prescriptions.

- A *database of patient records* derived from VistA. "… electronic medical records collectively form a powerful database that enables researchers to look back and see which procedures work best without having to assemble and rifle through innumerable paper records. This database also makes it possible to discover emerging disease vectors quickly and effectively. For example, when a veteran's hospital in Kansas City noticed an outbreak of a rare form of pneumonia among its patients, its computer system quickly spotted the problem: All the patients had been treated with what turned out to be the same bad batch of nasal spray."[14]

- Widespread use of *performance and outcomes measures*, even in difficult-to-measure areas such as mental health.

- A *technology assessment program* dedicated to facilitating evidence-based decision making using multidisciplinary policy analysis that applies the best-available scientific evidence on the medical, social, ethical, and economic implications of health care interventions.

The VHA's analytical efforts, along with other initiatives to improve care, have led to impressive results. Another recent RAND Corporation study found that VHA hospitals outperform all other provider sectors of American health care across 294 different measures of quality in disease prevention and treatment. The study found that the greatest differences between the VA and the national sample were for indicators where the VHA was actively measuring performance and for indicators related to those on which performance was measured. For six straight years, VHA has led private sector health care in the independent American Customer Satisfaction Index.

Fraud Prevention

Since health care payments are among the largest government payments to citizens, they are also often the domain for fraud. While Medicare fraud prevention is to some degree a focus for the federal government in the United States, prevention and reduction of Medicaid fraud is a much greater focus at both the federal level (the Deficit Reduction Act of 2005 increased penalties for Medicaid fraud and required organizations receiving substantial Medicaid payments to describe their policies for preventing fraud), and particularly at the state level, where Medicaid programs are administered. Many states have fraud prevention initiatives under way, and analytics is a key tool for identifying payments that may be fraudulent.

As a prominent example, New York State is the largest provider in the U.S. of Medicaid services, at $44 billion per year, and has a strong focus on analytics for fraud prevention. The New York State Office of the State Comptroller identified more than $150 million in Medicaid claim overpayments in 2005 and 2006 after analyzing historical claims data in the eMedNY data warehouse. These analyses identified duplicate payments, overpayments to health care providers, non-billing to Medicare, and miscoding of diseases and payments.

Because Medicaid payments in New York State are distributed through county governments, particular counties also have analytical fraud prevention initiatives under way. Onondaga County, for example, is using business intelligence and analytics tools to identify patients whose Medicaid prescription totals warrant fraud investigation. Nassau County on Long Island has launched two multimillion-dollar investigations based on data compiled using business intelligence tools to identify potential Medicaid fraud by county residents. County officials believe that they have saved millions of dollars in savings since 2003, when they began to use the software tools to analyze Medicaid claims. Nassau County is also using analytical software to identify fraudulent transportation claims for Medicaid reimbursement and saw claims decrease by $1 million after the initiative began.[15]

Stephen Acquario, executive director of the New York State Association of Counties, believes that business intelligence and analytics are confirming

that fraud and misuse are contributing to the substantial growth of Medicaid claims. "Anecdotes are no longer going to be the norm," he said. "Now, through statistical-driven reporting … we're able to back up what we had suspected in ways we were not able to do in years past."[16]

The Department of Veterans Affairs also employs analytics for fraud reduction through the Veterans Benefits Administration (VBA). The VBA matches income data with the Internal Revenue Service and Social Security to ensure the people who receive VA pensions (which are dependent on having low incomes) aren't getting more income than they are reporting. The VBA also analyzes high-value claims checks, which typically go to people who have had long-standing disabilities but have recently filed a claim. The organization produces a dashboard that the heads of regional offices use to adjust resources, and also has a dashboard that managers use to evaluate performance and manage their parts of the business.

Of course, fraud reduction can also apply in other domains of government health and human services. For example, in 2004, the state of Michigan implemented a "reverse wage match" to determine whether recipients of day care benefits actually received wages from employment; since 2004 the program has identified more than $17 million in fraudulent payments. In Food and Cash Assistance programs, Michigan has combined data from recipient electronic benefits transfers, food assistance records, participating retailers, and geocode data on store locations to identify sources of fraud. The system identifies fraud in terms of clients who have left the state but failed to report their departure, recipients who travel long distances to patronize stores, and excessive reimbursement requests from convenience stores and gas stations. While these fraud prevention efforts are important, the dollars spent on these programs are substantially smaller than those on health care; hence, the fraud prevention benefits are much lower as well.

Disease Management

In disease management, Medicare or Medicaid (or, in some cases, private health insurance) patients with chronic diseases such as diabetes or heart disease are enrolled in programs to help manage the disease and lower the costs of treatment.[17] A large

pilot study in the U.S. called Medicare Health Support is under way, with over 100,000 participants in eight regions. The programs are focused particularly on medical conditions that lead to high costs. The role of analytics in disease management is to identify the patients most at risk for diseases and high-cost conditions.

Two examples illustrate the problem that disease management is attempting to address. About 14 percent of Medicare beneficiaries have congestive heart failure, but these patients account for 43 percent of Medicare spending. About 18 percent of Medicare beneficiaries have diabetes, yet diabetes patients account for 32 percent of Medicare spending.[18] Disease management programs are designed to control costs and improve treatment by closely monitoring patients' conditions, educating them to manage more of their own treatment and supporting them in bringing about behavior changes that could improve their conditions. Patients are also reminded of tests and treatments needed at particular times in the course of their diseases.

While the programs provide services to all patients, those at particularly high risk of future medical complications are identified through predictive analytics. Individuals at risk are identified by disease-specific algorithms based on medical coding structures and, in some cases, pharmacy data. The analytical techniques employed include linear or logistic regression analyses, classification/decision trees, and neural networks. Identified patients receive additional health care or social/behavioral interventions designed to reduce the risk of avoidable, costly medical interventions in the future.

Disease management programs have been shown to foster improved health through prevented or delayed onset of complications and related diseases, resulting in less demand on the system and lower cost to government payors. Early studies have suggested that costs for patients in disease management programs are up to 25 percent less than those for control groups. However, analysis of initial outcomes for the 2005 Medicare Health Support program suggests that cost savings are not yet of sufficient magnitude to outweigh the management fees charged by the private sector organizations conducting the pilots.[19] Patients and caregivers have generally expressed high levels of satisfaction

with the programs, but greater efficiencies will have to be found if these programs are to proliferate more broadly.

The DELTA Model in Government Health Care

Since a major role for government in U.S. health care is as a payor, only some aspects of the strategic use of analytics would be relevant to government executives. From a payor's standpoint, the *data* that would be of primary interest would most likely involve whether reimbursements are being conducted effectively and legally. This is, of course, a focus at both the federal and state levels. But the fact that government payments are overseen at multiple levels creates an analytical problem from an *enterprise* perspective. Medicare payments are centralized, but Medicaid payments are overseen by states and even counties. The decentralized nature of the "enterprise" in this situation often prevents an extensive effort to analyze spending effectiveness and to reduce fraud. *Leadership* also suffers from this fragmented payment approach; there is no visible national leader to encourage an analytical perspective on medical payments. The *target* of analytical initiatives in health care payment is primarily disease management for Medicare and fraud reduction for Medicaid. Finally, there is clearly a shortage of *analysts* within government to perform analytical work on payments. Many of the analysts in this domain come from either outside disease management or consulting firms.

Provider organizations in the U.S. government, as noted earlier, are largely restricted to the Veterans Health Administration. This organization seems to have the *data* it needs, in part because of its relatively early adoption of an electronic health record system. It acts as one *enterprise*. It had strong analytical *leadership,* particularly in the person of Dr. Kenneth W. Kizer, the former under secretary for health in the U.S. Department of Veterans Affairs. According to *Business Week*, "In the mid-1990s, Dr. Kenneth W. Kizer … installed the most extensive electronic medical records systems in the U.S. Kizer also decentralized decision making, closed under-used hospitals, reallocated resources, and most critically, instituted a culture of accountability and quality measures."[20] Kizer had a strong emphasis on both "information management" and "performance management" in his critical success factors for the VA health system, which are critical precursors of an analytical orientation. The VA's *targets* were primarily around improving health care quality and performance (although, as noted earlier, the VA also does analytical work to prevent fraud on the benefits side of the organization). Finally, the VA seems to have had sufficient *analysts* to accomplish its analytical objectives (although it also employs outside contractors). While the VA hospital system could take an even stronger and more strategic analytical focus, the organization seems to have done quite well with the resources available.

Supply Chain and Human Resource Analytics in Government

One of the most important domains for analytics in the private sector is in supply chain management, where companies attempt to optimize resources and distribution channels. More recently, organizations have begun to focus on the "human supply chain," or the use of analytics in human resource processes. These two areas are also important for governments, and their most aggressive application has been in the military.

The Origins of Supply Chain Analytics

Supply chain analytics arose out of the analytical discipline of "operations research." These applications were used early on within branches of the government—specifically in the military. Because of competitive needs and the drastic consequences of running out of materiel in wartime, analytics has long been employed in forecasting, supply route optimization, and naval and air force operations. Optimization models were employed in World War II by both UK and U.S. researchers—for example, they were used to design optimal shipping convoys and bomber flying patterns.[21] In England, the Royal Air Force used both radar and operations analysis to defeat a numerically superior German foe in the Battle of Britain.[22] Sir Arthur Harris said his Bomber Command's Operational Research Section "had saved the lives of thousands of aircrew and hundreds of aircraft, as well as being an indispensable aid to military effectiveness."[23]

By the Vietnam War, operations research was widely accepted and used broadly within military operations, in part because Robert McNamara, a strong believer in analytical tools, was secretary of defense. At times, the military's use of analytical techniques led that of the private sector.[24] While many of their

military approaches were successful, they have also been accused of a mindlessly quantitative approach to decision making (as with "body counts" in Vietnam, for example, during McNamara's tenure as secretary of defense in the 1960s, when he recruited a second generation of "whiz kid" analysts to staff his policy offices).

The military remains a leading user of supply chain analytics today, although private sector firms such as Wal-Mart typically employ more sophisticated analytical approaches than the military. In part this is due to the greater complexity of the military supply chain, particularly in wartime. In wartime operations, the tempo, volatility, and stakes are dramatically higher, and the variables more difficult to model. In wartime, the competition is actively trying to (1) destroy your resources and logistics pipeline, and (2) to create demand for what you're already short of. There is also no fixed end point to the supply chain; it moves as battles unfold and as military forces move. Therefore, military analysts have found it difficult, if not impossible, to fully model the military supply chain during wartime.

Current Approaches to Supply Chain Analytics

Today, however, some analytical approaches are being employed within the military to manage inventories and supply lines. The U.S. Army, in particular, has changed its supply chain model over the past decade or so from one based on "mass"—moving large quantities of heavy goods with a "just-in-case" approach to inventory—to one based on "velocity," or a more agile, fast-moving supply chain that operates on a just-in-time inventory basis.[25] Rather than detailed analytical modeling,

the focus over the past several years has been on determining and measuring process flows, and converting Army officials to the new supply mind-set. Part of the change involved shifting to new metrics, such as the "customer wait time" measure employed in the private sector.

Within this velocity-based approach, however, it is critical—more so than in the private sector—to avoid shortages of critical supply items. To improve the likelihood that needed parts are available, the Army employs an analytical approach called "dollar cost banding."[26] This algorithm for inventory management adjusts "the criteria for determining whether an item should be added or retained according to the item's criticality, mobility impact, end item density, and dollar value." Items that don't cost much to store as inventory, but are mission critical, are more likely to be kept in stock than larger, heavier, and more expensive items. The dollar cost banding algorithm has proven to be more effective than the previous "days of supply" algorithm used by the Army to prevent stock-outs while still lowering the cost of carrying inventory. Most importantly, repair times for key military equipment (such as tanks) have been reduced by as much as 29 percent. The decision rules for the new algorithm also can be automated, which reduces the burden on Army supply managers.

Logistical analyses may happen both at some remove from battlefield activities and in close proximity to them. They may be done in isolation or as part of an overall set of battlefield course-of-action alternatives presented to battlefield commanders. Battlefield operations analysts may also collaborate closely with commanders to provide insights on how best to achieve their objectives. According to one inventory of field-based U.S. Army operations research analysts in 2005, there were:

- Six with the Multi-National Forces–Iraq

- Three with the Multi-National Corps–Iraq

- Two with Combined Forces Command–Afghanistan

- One with Combined Joint Task Force-76 in Afghanistan

- One with the Headquarters, 3rd Infantry Division (UEx)

According to Lieutenant General David Melcher, the deputy chief of staff, their presence was at the request of field commanders, and the organizational designs for Army transformation call for specified numbers of analysts at particular points in the field hierarchy.[27]

Human Resource Analytics

The military has also increasingly employed analytical approaches to the human resources "supply chain." Particularly in wartime with an all-volunteer military, the U.S. armed forces are turning to analytical decisions related to recruitment. The analytical domains include forecasting, recruiting segmentation and pipeline models, attrition models, and force reduction strategies. Forecasting analytics generally takes place at the level of large military populations (for example, specific services such as the Army or the civilian force within the Army) and includes modeling and testing of alternative policies and resource (for example, enlisted vs. civilian vs.

Typical Analytic Applications in Supply Chain

From Davenport and Harris

Capacity planning: Finding the capacity of a supply chain or its elements; identifying and eliminating bottlenecks; typically employs iterative analysis of alternative plans.

Demand-supply matching: Determining the intersections of demand and supply curves to optimize inventory and minimize overstocks and stockouts. Typically involves such issues as arrival processes, waiting times, and throughput losses.

Modeling: Creating models to stimulate, explore contingencies, and optimize supply chains. Many of these approaches employ some form of linear programming software and solvers, which allow programs to seek particular goals, given a set of variables and constraints.

contractor) mixes, and the impact of realignments, incentives, retirements, and so forth.

Of course, military staffing can become a political issue that may overshadow analytical planning for optimized resource levels. For example, RAND analysts studied the ratio of occupying forces to population levels in several "nation-building" exercises after World War II, and concluded that in order to keep the peace in Iraq, over 500,000 troops would be required.[28] The U.S. administration found that number politically unpalatable, however, and deployed less than a third of that number. Analysts may have done their jobs (and hindsight has largely suggested that they were correct), but decision makers relied on other criteria.

Recruiting for the armed forces is increasingly viewed as similar to a marketing and sales exercise, and many of the same techniques employed in commercial firms to attract customers are being employed to attract recruits. Segmentation models employ geodemographic data to determine which types of potential recruits should receive which promotional materials.[29] Pipeline analyses model the number of recruits at every stage in the recruiting process (similar to a sales lead pipeline) and alert recruiters when the pipeline falls below desired levels. The U.S. Army Recruiting Command, for example, uses geospatial data in its Graphical Accessions Mapping Analysis Tool (GAMAT), which tracks the progress of recruits from first contact through boot camp and presents the information to recruiters in geographic form.[30] Recruiters also have access to online market penetration analyses and their own performance reports.[31] Attrition models are used to identify recruits that have had some contact with the Army, but who have not yet enlisted and who are in danger of falling out of the process.

Supply chain and human resource analytics for the U.S. military are most actively pursued outside of government, in research centers, consulting firms, and universities. The RAND Corporation has been particularly active in both supply chain and human resource activities on behalf of the U.S. Army. RAND's Arroyo Center is the Army's only federally funded research and development center. In addition to traditional military research programs on strategy and technology, Arroyo has a "Military Logistics" program that carries out analysis on supply chain

programs, and a "Manpower and Training" initiative that "applies sophisticated economics and social science methodologies to Army personnel and training issues. It stresses quantitative analysis and testing of alternative policies and resource mixes, all oriented toward choosing appropriate strategies for manning, training, and structuring the Army for the future."[32]

Consulting firms also play a role in analytical research and practice development. Booz Allen Hamilton, for example, has worked with the U.S. and other governments on analytical projects since the late 1940s. Today large consulting firms around the world work on complex projects assisting governments to manage operations and supply chains.

Researchers at several military-oriented universities and colleges assist in analytical supply chain projects. The Industrial College of the Armed Forces, Defense Acquisition University, the Naval Postgraduate School, and some faculty at the U.S. service academies have done substantial work on behalf of the military in the realm of supply chain and human resources.

Inside the military, the primary sources of supply chain analytical expertise are within individual services, and in cross-service organizations such as the Defense Logistics Agency (DLA). Demand planners at the DLA, for example, work with military customers to develop demand plans based on statistical forecasts. Individual services also have logistical units, such as the Army Materiel Command organization, that create demand plans for service-specific supply items. Unfortunately, the prevalence of different organizations doing supply chain work for the military often causes problems. For example, there is no unified approach to how to deal with supply containers in war zones.

The DELTA Model for Supply Chain and Human Resource Analytics

The DELTA model for supply chain and the "human supply chain" has some similarities to those of the other analytical domains in government. The amount of data for this area is increasingly not a problem, as the various branches of the armed services and the Defense Logistics Agency install enterprise resource planning (ERP) systems that track movements of goods and people. The primary problem from the *data* perspective is that

each branch of the military (Army, Navy, Air Force) has a different ERP approach and strategy. Even if the desire existed to do analytics across the different services (which is questionable), it would be difficult given this data environment.

In the same sense, the military has a problem with the *enterprise* component of this model, in that there are not only multiple military services, but also multiple supply chain organizations serving them. *Leadership* is also a problem in such a fragmented environment; while particular commanders may have an analytical orientation, this has not been a focus at the level of the joint chiefs or other combined military organizations. Efficient, effective replenishment of both goods and people has been the primary *target* of analytical efforts in government; it is probably helpful that the target is so straightforward. Finally, there is a lack of *analysts* in the government itself, but the military has sufficient resources that it has been able to buy them from the RANDs, the Booz Allens, and the many professional services organizations that serve the government.

Analytics in Government Revenue Management

Revenue management in government involves efforts by tax authorities to maximize the amounts of revenue legally collected from citizens. Tax revenue agencies report significant increases in collections from analytics—on the order of 10 to 15 percent. Tax agencies have a great need to improve their yield from their taxable populations. Many tax revenue agencies are facing increasing population and business growth, yet must simultaneously deal with declining internal resources, the mass exodus of seasoned workers due to retirements, and legacy information systems.

The tax agencies primarily use analytics to address the "tax gap." The tax gap refers to the lost revenue when agencies do not effectively identify, audit, and collect overdue taxes. Lost revenue in uncollected and underreported tax revenues leads to massive budget cuts in critical state and local services and resources, and impacts the public in general. The U.S. Internal Revenue Service estimates that tax agencies typically lose 15 percent of total revenues to underreporting, tax evasion, and other types of noncompliance. The tax agencies' mission is to ensure that everyone pays their fair share of the cost of government, not just those who are compliant. The tax agencies must meet this mission despite changing tax statutes and more rigorous privacy requirements.

Reducing the tax gap involves, among other things, segmenting the constituency base of citizen and business groups for their highest expected net revenue contribution. Infrastructural advances such as e-government, electronic filing of tax returns, tax portals, desktop statistics software, and investments in enterprise data warehouses, among others, have made analytics more feasible in the revenue management process.

Analytics is playing an increasingly critical role in at least four domains of governmental revenue management:

- Revenue analysis
- Compliance systems
- Fraud detection
- Taxpayer customer services

These applications promise to deliver financial benefits as well as improve the public image of tax agencies and the government overall. In the U.S., both the federal government and state tax agencies have developed their own analytical models for these domains. State-specific models are needed as taxpayer behavior changes across and even within states. Many analytical applications in revenue management have received awards from industry groups and vendors.

Revenue Analysis

Revenue analysis involves performing micro-level revenue forecasts on an individual firm, citizen, or a small group. The forecasts are used to anticipate taxpayer behaviors from new legislative or executive policies or changes to existing policies, particularly during fluctuations in the economy at the national and state levels.[33] Data analytics is also useful in identifying a problem from tax data or noticing the inclination for a problem from recent legislation or noncompliance to legislation before it grows into a much larger issue. What-if scenarios provide insight into future probabilities and trends (for example, predicting an increase in farm tax revenue due to high levels of corn seed purchases). Data analytics is also used to project expenditures to make sure that

the states stay within their budgets (for example, Florida and California). Although revenue analysis applications are widespread in the U.S. as well as other countries at the sectoral (macro) level, they are still evolving at the micro level. Desktop hardware and graphical interfaces have eased the model permutations and enabled real time, iterative runs during legislative deliberations.

The Congressional Budget Office of the U.S. federal government has developed an individual income tax model to project individual and aggregate tax liability for future tax years. Such projections are necessary to ensure that sufficient tax revenues will be forthcoming to fund new governmental programs. Several states, including Iowa, have developed forecasting models that predict individual income. Such forecasting helps to understand the shifts in taxable revenue as the baby-boom generation retires; Iowa's tax code includes several preferential provisions for the elderly.[34]

In 1994, the state of California passed a law that required the California Department of Finance to develop a dynamic revenue analysis model for tax bills with significant fiscal effects. The law was enacted to deal with the highly volatile revenue system. The state was experiencing rapid increases in personal income tax as a percentage of the total tax revenue, with increased concentration of income at the high end. High-income taxpayers have volatile income sources (stock options and capital gains). California's dynamic revenue model was to take into account the probable behavioral responses of taxpaying individuals and businesses. The size of the model had grown to some 1,100 equations at the time the law was sunset in 2000 because California's policy makers did not extend the law. Although the quantitative benefits of the dynamic revenue estimation faced many challenges (particularly because of data and specification problems), the qualitative benefits were much less under debate. Dynamic revenue forecasting provided new and useful insights and opened new lines of discussion regarding the ramifications of tax policy changes.[35]

Compliance Systems

Data analytics can help reduce tax gap (lost revenue) by improving tax collection with the same or even reduced resource levels. Compliance applications focus on getting the right cases assigned to the right people, for the right action at the right time.[36] The applications address one or more of the following areas:

- Discovery of nonfiling businesses and individuals with potential tax liabilities

- Selection of those taxpayers for audit who are likely to underreport

- Application of risk-based collection strategies for each collection case

Whereas in the U.S. and Canada, many of the applications focus on identifying nonfilers and/or optimizing tax collection strategies, the emphasis in European tax authorities has been the application of analytics to the auditing of tax returns.

Discovery of Nonfilers

By the 1980s, the U.S. Internal Revenue Service (IRS) had developed scoring systems to identify those most likely to be nonfilers or those underreporting their taxes. Called the Taxpayer Compliance Measurement Program, the scoring system was validated through detailed audits of selected taxpayers. The use of scoring has been demonstrated to result in higher tax assessments.[37] More recently, the IRS has improved its capabilities to detect tax cheaters among corporations with offshore operations.

Many states have built data warehouses and engaged in matching records to identify nonfilers of taxes. These include states like Virginia and Massachusetts. The state of Massachusetts uses an off-the-shelf tax recovery program to perform record matching with nearly 50 databases such as Internal Revenue Service, U.S. Customs, state licensing boards, business filing of unemployment insurance, customer records, and so on. Such matching programs can identity a company reporting a certain number of employees on its payroll to state tax agencies, while providing another figure when reporting unemployment compensation benefits. The system identifies taxpayers who owe taxes but have not filed returns, as well as people who are underpaying or overpaying. Discovery of nonfilers cost the state $6 million while bringing in $325 million in additional revenues.

Massachusetts is also using Clearinghouse, a collaboration among eight state tax commissioners, to search tax cheaters who are exploiting state

boundaries. Massachusetts has spent about $500,000 to launch the operation. The goal is to make this system operate in real time (verifying the accuracy of the claim when the taxpayer claims a credit from the state of Massachusetts).

One of the first states to use predictive modeling analytics to identify nonfilers was Texas. The state enacted enabling legislation in 1997 that allowed it to build a data warehouse and a year later to have a system in production for the tax discovery (nonfilers) group. The enabling legislation was needed to accommodate benefit-based funding of the system. The system matches data from U.S. Customs and Border Protection, employment records, state motor vehicle and private airplane registrations, and so on, with franchise tax (business tax) filers and sales tax records. It has found many nonfiling businesses for franchise and sales tax liabilities. For example, one business had bought three airplanes in one year but was reporting no sales revenue. As the system was benefit based, Texas spent on the vendor some $4.7 million that helped return $48 million. The state has also considered tapping into commercial sources such as Dun and Bradstreet databases to find non-registrant businesses and nonfiling taxpayers, but has yet to do so.

The state of California has employed a variety of data sources—including IRS data, wage and sales tax information, property sales, and mortgage interest—to identify nonfilers. The California Franchise Tax Board identified 800,000 nonfilers, recovering $350 million in taxes. Costs were recouped within one year. The agency estimates $36 million annually in new tax revenue.

Matching applications of different data sources often produces too many leads. Given the limited staff available to follow up, predictive modeling is used to prioritize the leads and predict the tax dollars owed by the organization or individual taxpayer. Data mining is also used to analyze if existing tax-payers have liabilities for other tax types than what they have filed.

Audit Selection

Predictive models are also used to select tax returns for audits. The tax administrators have much knowl-edge of what types of errors taxpayers make and why based on historical data. Predictive models

help to increase this knowledge by developing the profiles of those taxpayers which were found to be highly compliant during prior audits. These models help to identify those taxpayers that are most likely to make errors and predict how large of an error they have made. The predictive models are used to identify compliance problems at the time a tax return is filed. The solutions are capable of data mining thousands of tax returns in seconds, and can potentially help save years of tracking, investigation, and collection costs. Audit selection is most effec-tive when there can be an early detection and rapid follow-up. In most cases, the audit selection solu-tions provide only decision or informational support to the auditors; it is up to the human auditors to act upon the information.

Analytics-based audit systems have been imple-mented in South Carolina, Iowa, Texas, Virginia, Kansas, Massachusetts, and Connecticut. The California Board of Equalization (which manages sales tax) is also making progress toward the full deployment of scoring models for audit selection. Texas located $400 million in unpaid state revenues between 1998 and 2004, and expects to collect about $70 million a year over time. Virginia reported to have located $73 million. South Carolina expected to collect $100 million in the first five years from its compliance solutions.

Collection Strategy

The earliest applications of analytics in tax agencies were in collections. Currently, about 20 percent of the states in the U.S. have implemented risk-based collections including California, South Carolina, Missouri, Michigan, Massachusetts, Virginia, Arizona, and Iowa. Texas has also recently imple-mented its collection models, although the models are under further development. The collection appli-cations enable agencies to maximize overall collec-tions while minimizing the amount of resources to handle the collection of unpaid tax. Risk-based col-lections work on the assumption that taxpayers have different levels of risk of nonpayment. The applica-tions assign taxpayers to different classes of collec-tion strategies/treatments based on their likelihood of paying. Different strategies treat taxpayers differ-ently from the beginning to the end of the process. Those considered low risk are sent a "softer" letter and allowed more time to respond than those con-sidered high risk. The agencies report that many

accounts close before a phone call is needed. High-risk taxpayers are moved to enforced collections as quickly as possible because timely field enforcement increases the probability of collection. For example, in Iowa, the increased revenues from an improved collection strategy were estimated to be $4 to $5 million in less than one year. Annual projections are in the $4.5 to $9 million range with future opportunities identified worth $12 to $29 million per year.[38]

In some states (for example, South Carolina and Massachusetts), the models not only segment taxpayers, but also in some cases determine what actions to take and drive interactions with the clients. These compliance solutions go beyond prediction to optimization. Optimization extends analytics into the area of treatment strategy design, taking into account the taxpayer's history and circumstances.[39] Optimization yields higher returns but also requires major organizational change in the agencies.

Canada Revenue Agency has also embarked on an ambitious plan to build sophisticated models for auditing and collections, along with the United Kingdom and Australia. Of the continental European countries, in Belgium and Sweden the tax authorities have major programs under way to exploit data analytics in audit selection of tax returns.

Fraud Detection

As tax refund fraud schemes have become more sophisticated, tax agencies have had to deploy more powerful methods to stop fraudulent return checks before they go out, while maintaining expected refund times and avoiding inconvenience for compliant taxpayers.

At the U.S. Internal Revenue Service, the Electronic Fraud Detection System (EFDS) evaluates every tax return requesting a refund to rate potentially fraudulent individual tax returns. About 80 percent of returns requested a refund in 2005. The system includes only personal information (no private sector data and no other agency data). The prototype was first introduced in 1995 and deployed nationwide for the tax year of 1996.

At the IRS, a consulting firm was hired to deliver an updated web-based version of the existing client/server-based system by January 2006. However, the implementation was unsuccessful and the 2006 tax

season had to proceed without any electronic detection system in place. The IRS estimated that it paid over $300 million in bogus tax refunds. The treasury inspector general for tax administration released a report on an investigation into the troubled system in spring of 2007.[40] Work is under way to restore operations of the client/server-based EFDS system for the tax year of 2007.

In addition to refund fraud, preparer fraud has grown more significant. For example, preparers convince uninformed people that they qualify for a "refund program" and then file on their behalf. New York State has developed a predictive modeling application that evaluates returns in semi-real time to look for preparation patterns (for example, high deductions), audit questionable returns, and then potentially prosecute for preparer fraud. New York State has also developed a very successful analytical system to identify fraud and abuse of the Earned Income Tax Credit (a welfare benefit for low-income individuals).

Businesses, particularly self-employed businesses, sometimes falsify income to qualify for tax credit programs. Iowa has experienced a decline in corporate income tax collections for about two decades. The drain in tax collections points to corporate income tax credits. In response to state legislation, the Iowa Department of Revenue developed a Tax Credits Tracking and Analysis System to monitor and consolidate tax credits by taxpayers. The agency is also expanding the system to include analysis of all credits awarded by agencies to certain self-employed business classes (for example, contractors and consultants).

Taxpayer Customer Services

The emerging area for analytics in revenue management is taxpayer customer services. The applications are similar in some ways to customer services analytics systems that have long been in commercial use in the private sector. These systems are typically based in customer relationship management (CRM) applications, and identify customers who are likely candidates for some sort of intervention. Taxpayer services provide proactive interventions to reduce nonfiling and underreporting. The applications exploit models that evaluate inbound telephone calls and assess the likelihood that the taxpayer has not registered for all necessary tax types, does not

understand the tax law change, will become a non-filer, or will likely have certain types of questions. Such systems also often involve an outreach educational component. The Massachusetts Department of Revenue is an agency that has worked on taxpayer analytics services. Future versions of the system may leverage data sources such as auditors' notes.

Some of the taxpayer services will be built on the case management systems that are already in use in many states. These systems are designed to manage all interactions with customers across various channels, including mail, call centers, and websites. For example, the California Franchise Tax Board uses a case management system with an integrated web and interactive voice response front end for improved customer service. The system can be used by nonfilers to request additional time to reply to their notices and grant extensions online via a web-based interface.

The DELTA Model for Revenue Management

About 20 percent of the states in the U.S. deploy analytics as part of their compliance systems. As one consultant remarked, "Analytics represent a niche market, with few states taking it seriously." Many of these are in relatively early stages of implementation. Although the access to *data* is increasingly less of a problem (some note that the problem is too much data), data quality can be an issue, although usually a manageable one. Many states have implemented data warehousing strategies. However, some states have built up analytics infrastructure but because of the lack of *analysts* and the necessary *leadership* are unable to exploit their infrastructure. In some states, leadership remains skeptical whether data analytics yields better outcomes than traditional methods.

The *targets* are primarily tactical and operational, such as dollars assessed and recovered per audit hour. For the most part, the projects have met their operational targets, recovering tens of millions of dollars in unpaid taxes annually in various states. While such targets can be most helpful in managing and evaluating specific projects, the initiatives have lacked the longer-term horizon and strategic purpose that are also needed.

Revenue management also lacks an *enterprise* focus, although there is an increasing awareness of the need to integrate analytical activities with broader work flow processes at the departmental level and even at the agency level. But tax and revenue management is spread through a variety of different tax agencies with widely different missions. We found little collaboration among the different state agencies charged with revenue responsibilities regarding their analytics. Even within the same tax and revenue agencies, departmental boundaries hindered collaboration on analytics. There was, however, considerable collaboration across state agencies (visits, presentations, conferences) with similar responsibilities. Much of this collaboration occurred through professional and federal groups as well as skilled and experienced consultants. Many of these consultants had built their expertise in the private sector and are now leveraging it in the public sector. However, consultancies tend to "contribute more to the innovative process, than to the new sustainable capabilities" in daily work practices.[41] Those agencies that have had sustained success with analytics (such as Massachusetts and Texas) have engaged themselves in long-term relationships with the same consultancies. Yet, as one of these consultants with a long-term agency relationship noted, "Consultants cannot lead these projects…."

Intelligence as an Analytical Domain

In addition to health care, supply chain management, and revenue management, there are, of course, other analytical domains within government. One of the most important is intelligence. Some areas within intelligence are highly analytical—for example, the perusal of global telecommunications traffic. Traditional "spying" or intelligence agent activities, however, are much more difficult environments in which to gather data, quantify observations, and perform quantitative analyses.

Types of Intelligence

If one breaks down intelligence into four different types of information gathered, as did a U.S. congressional commission in 1996, the latter three types are heavily analytical and quantitative:

- **Human source intelligence**, or HUMINT, is the operational use of individuals who know or have access to sensitive information that the Intelligence Community deems important to its mission. The Central Intelligence Agency and the Defense HUMINT Service, an element of the Defense Intelligence Agency, are the primary collectors of HUMINT.

- **Signals intelligence**, or SIGINT, consists of information obtained from intercepted communications, radars, or data transmissions. The National Security Agency is the primary collector. Within the SIGINT discipline, there are subcategories of communications intelligence, electronic intelligence (essentially emanations from radars), and foreign instrumentation signals intelligence (such as automated data from space vehicles).

- **Imagery intelligence**, or IMINT, is the use of space-based, aerial, and ground-based systems to take electro-optical, radar, or infrared images. The National Geospatial-Intelligence Agency coordinates imagery collection and processing.

- **Measurement and Signature Intelligence**, or MASINT, is the collection of technically derived data that describes distinctive characteristics of a specific event such as a nuclear explosion. The Defense Intelligence Agency and the military services are the primary MASINT collectors.[42]

There is little doubt that there is considerable analytical processing applied to signal intelligence, or SIGINT. The National Security Agency is one of the world's largest consumers of high-powered computers, and numerous vendors assist intelligence agencies with specialized software and hardware. For example, Nice Systems, an Israel-based vendor of analytical software for the analysis of communications content, notes that it works with governments as well as corporations. The company offers intelligence agencies "interception, mediation, collection and analysis of telecommunication interactions for both telephony and Internet data."[43] However, neither Nice nor other sources reveal the details of how analytical approaches are applied in this context.

There is also considerable interest and activity in the area of analytics for image intelligence, or IMINT. A walk down Main Street in virtually any city will confirm that video image capture is a growth industry for both the private and public sectors. Because there are not enough humans to economically analyze all the video footage for terrorism or crime threats, companies are embracing analytical approaches to identifying threats. This capability is called "video analytics" or "intelligent video surveillance." The Central Intelligence Agency's (CIA) venture capital arm, In-Q-Tel, has invested in one

company that provides this type of solution.[44] It is obvious why that organization would be interested in the technology, but of course no details of its interest are publicly available.

Quantitative analysis can also be applied to other intelligence contexts, such as identifying state and regional instability. A Military Operations Research Society Working Group in 2004 reviewed instability forecasting approaches and identified two different approaches:[45]

- **Strategic forecasting models:** forecast several years ahead the likelihood that states will fail or will become unstable based on quantitative analysis of social, political, demographic, and economic factors. Examples include the CIA's Political Instability Task Force and the Center for Army Analysis' ACTOR (Analyzing Complex Threats for Operations and Readiness) model.

- **Operational forecasting models:** monitor, assess, and forecast trends in behavioral interactions between people, organizations, and states, and predict changes at the event level. Examples include Psynapse Technologies' ABC Terrorism Prediction Model, which mines textual reports to forecast terrorist attacks, and the Center for Army Analysis' FORECITE Monitor, which collects data for indices of the "character and intensity of interactions between individuals, organizations, and states."

Need for More Analytics in Human Intelligence

Although there are many examples of quantitative analytical approaches to intelligence, a recent study of the HUMINT intelligence community in the U.S. suggests that its processes are not sufficiently analytical. Rob Johnston, an anthropologist, studied the U.S. intelligence community in depth just after the September 11, 2001, terrorism events. One of his key findings was that the intelligence community does not have an orientation to scientifically valid analytical approaches. Rather than scientific analysis, it practices "tradecraft":

Tradecraft purposefully implies a mysterious process learned only by the initiated and acquired only through the elaborate rituals of professional indoctrination. It also

implies that the methods and techniques of analysis are informal, idiosyncratic, unverifiable, and perhaps even unexplainable … there is no formal system for measuring and tracking the validity or reliability of analytic methods, because they are both perceived and employed within the context of idiosyncratic tradecraft.[46]

Quotations from Johnston's 489 interviews illustrate the issue:

- "What we do is more art and experience than anything else."

- "Science is too formal. We can't actually run experiments here."

- "How would you actually test a hypothesis in intelligence?"

- "Science is what you do in a lab."

- "We're not scientists; we're analysts. We don't generate the data."

The absence of a more rigorous scientific approach to methods means that the intelligence domain will find it difficult to ever measure or improve itself in a disciplined way. Johnston's findings are a reminder that simply talking about "analysis" does not necessarily mean that a rigorous, scientific analysis of data is being undertaken. His anthropological research approach is also a reminder that the culture of an organization (or, in this case, a larger community) can be an important determinant of the analytical approach it employs.

The DELTA Model for Intelligence Analytics

In all but the HUMINT approach to intelligence, there is plenty of *data*—in some cases perhaps almost too much to deal with. The ethnographic research by Johnston suggests that HUMINT could become more data focused.

It is perhaps the *enterprise* dimension of the DELTA model that causes most of the problems in the U.S. intelligence community—for analytics and many other issues. The intelligence community is still fragmented across many different organizations—the CIA, the FBI, the Defense Intelligence Agency, the

National Security Agency, and so on. There is no common approach to analytics across these groups and no good approach to managing or even sharing data across them.

The relatively new Office of the Director of National Intelligence was established to create a "single enterprise" approach to intelligence, but it is small relative to other intelligence agencies and is now working to increase analytical collaboration. According to our interviews, the director of national intelligence—currently former Navy admiral Mike McConnell—is attempting to develop a more analytical orientation in the community, and certainly to create more sharing of data and knowledge. One of his first actions was to announce a 100-day plan to develop greater integration and collaboration across the intelligence community; he also supports an "Information Sharing Environment" initiative. His is the only visible *leadership* role in this regard with respect to the U.S. intelligence community overall.

Identifying terrorists and preventing terrorism has become the primary *target* of analytical work in intelligence. Only time will tell whether this is the right approach for the U.S. government to emphasize. Finally, the intelligence agencies are perhaps the only branches of government that have plenty of in-house *analysts*—and even they are heavily supplemented by external FFRDCs and contractors. Analysts are not the problem in intelligence.

Conclusion: Analytics as an Effective Tool for Government

The transformation to analytical competition in private sector firms is a long-term, broadly focused organizational transformation. In order to truly compete on their analytical capabilities, organizations must transform not only their technology and data, but also their cultures, their business processes, and the day-to-day behaviors of their employees. Historically, information technology applications that challenge the prevailing institutional logic are short-lived and ultimately unsuccessful. Sustained long-term change in the public sector will require the same types of organizational transformation and managerial innovation as seen in the private sector.

Few agencies we studied were examples of such transformations. In these agencies, the interviewees described mutual adaptations to policy or strategy from leveraging analytics. For example, in one state tax agency, analytics has begun to have an impact on the strategy design of the agency. Analytics is used to improve customer service in addition to compliance. This is also accompanied by structural changes to leverage the knowledge more efficiently between the areas of auditing, collections, and customer services. Other agencies noted changes in tax legislation because of the knowledge gained from analytics.

Sweden: Strategic Analytics in Government

We did find an example of a highly strategic application of analytics in government. In Sweden, the leadership of the national tax agency has risen to the occasion of transforming its managerial processes. The transformation has come on the coattails of a new broadened agency mission and centralization of what was formerly a highly decentralized organization. The agency has an aggressive goal of reducing the lost revenue from the "tax gap" by half by 2012. The agency has invested in analytics infrastructure as part of its knowledge-based strategy. This strategy calls for increasing the agency's knowledge of taxpayer behavior; the knowledge is leveraged to take actions that improve citizens' confidence in the tax authority; improved confidence increases tax compliance. The analytics directly supports the knowledge-based strategy and transformation of the underlying institutional logic.

The agency set a broad goal of improving the confidence of taxpayers in the tax authority. Studies helped it to determine that confidence in the tax authority is the most effective and efficient way to improve compliance. The analytics activities brought knowledge about taxpayer behaviors and their common errors. This knowledge was used to change the tax forms so that taxes are done right from the start. Because the analytical activities are linked to a larger agency "target" of taxpayer confidence building, the analytics activities are visible and of interest to the highest levels of the agency leadership.

The knowledge from analytics is not only used to change the agency managerial processes and interactions with taxpayers, but also to shape the broader tax system. One of the agency's studies revealed that about 35 percent of the sales of international share funds were declared incorrectly by private persons in their tax returns. The errors were largely due to oversight or lack of information about how to declare the sales. The agency engaged in a communications campaign to educate the taxpayers. The errors continued and even increased even after the agency's communications campaign. A follow-up study was undertaken to understand more deeply

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Signposts of Effective Use of Analytics in Government

Adapted from Davenport and Harris

- Analysts have direct, nearly instantaneous access to data.

- Managers focus on improving processes and performance, not culling data from laptops, reports, and transactions systems.

- Data is managed from an enterprise-wide perspective throughout its life cycle, from its initial creation to archiving or destruction.

- High-volume, mission-critical decision-making processes are highly automated and integrated.

- Reports and analyses seamlessly integrate and synthesize information from many sources.

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the taxpayer behavior. The root cause was in lazy compliance attitudes of taxpayers. The agency convinced the Ministry of Finance to change the legislation to avoid the problem. The legislation meant that the sales of foreign funds were automatically populated to the tax return without any involvement of the taxpayer. The agency was concerned about raising fears of "Big Brother" and deliberately used the media to portray an open and transparent organization with integrity in its actions.

The Swedish tax agency illustrates how the use of analytics to create sustained value requires managerial innovation. Managerial innovation requires coordination of complementaries of strategy, organization structure, policy, processes, and so on. Managerial innovations require direct involvement of the highest level of agency management; commitment to a long-term, big strategic initiative; and the adoption of new institutionalized values, processes, and practices. Just as growing numbers of private sector firms have begun to make analytics the core of their strategies, government organizations can also put this powerful resource at the core of their efforts to achieve their missions.

Next Steps: Implementing Analytics in Government

Just as growing numbers of private sector firms have begun to make analytics the core of their strategies,

government organizations can also put this powerful resource at the center of their efforts to achieve their missions. We can use the DELTA model to hypothesize some of the next steps that government agencies might take in order to develop more strategic approaches to analytics.

Many government agencies have considerable *data* at their disposal from various forms of transactions, but they do not often analyze the data in detail to identify opportunities for better service or more revenue. In many cases, they have limited resources to prepare data for analysis. However, this does not mean that they cannot move forward to take advantage of the data. We found several examples of public-sector/private-firm partnerships in which the private firms' fees were paid in part from efficiencies or fraudulent benefit recoveries. Such partnerships would be more difficult in agencies not oriented to revenue collection or benefit disbursement (such as defense or intelligence), but in the current governmental climate in the U.S., defense and homeland security agencies are relatively well funded and may be able to afford analytical initiatives on their own.

We view the *enterprise* orientation of governmental agencies as a key factor in developing successful analytical approaches. Managers in governmental organizations around the world can increase their analytical sophistication by partnering with other internal functions, other agencies at the same level, or even government agencies in completely different jurisdictions. Tax evasion, for example, often occurs across state and national lines. Disease management in health care would undoubtedly benefit from consolidation of data in individual Medicaid programs, just as state-level Blue Cross and Blue Shield programs are sharing and consolidating their health data. The various branches of the military would ease battlefield analysis considerably—and have considerably more resources for analytical work— if they employed the same underlying systems and data. Cross-jurisdiction analytical efforts will probably encounter challenging data standards issues, but the payoffs can be high.

Perhaps most importantly, governmental organizations need a generation of analytical *leadership* if they are to use this tool strategically. Governmental leaders must learn what analytical capabilities can do for their agencies and jurisdictions, and develop

their own skills as well as those of their employees. Schools of public policy can play a helpful role in educating leaders and managers about the potential uses of these powerful tools. Leaders of private sector firms that have excelled at analytical competition can be brought in to advise governments on how best to move in this direction.

We also found a lack of strategic *targets* in many of the governmental organizations we interviewed and surveyed. Selecting targets is another function of an organization's leadership. A knowledge of analytical tools must be paired with a clear understanding of an organization's strategic priorities if capabilities are to be put to their best use.

Finally, governmental organizations need to develop a cadre of *analysts*—both professional and amateur. Analytical professionals—those who can develop new algorithms and quantitative models—are already present in some data-intensive agencies, such as the Bureau of Labor Statistics. Hence, there is reason to believe that they could be recruited elsewhere. Those governmental organizations that, for whatever reason, cannot hire their own analysts can attempt to source them through consulting and contracting relationships. And as analytics becomes embedded into key governmental processes, those who work with them on the front lines—for example, call center agents who discuss tax returns—will need to be generally aware of, if not expert on, the analytical tools used to carry out an agency's work with citizens.

As with any form of managerial innovation, developing a strategic approach to analytics will be difficult. As we have noted, it may take substantial time, as it sometimes has even in the resource-rich private sector. However, the relatively few examples we discovered of a strategic orientation to analytics, such as in the Veterans Health Administration and the Swedish Tax Agency, are both evidence that it is possible and that the potential returns are worth the considerable effort required.

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