Driving the Next Wave of IT-Enabled State Government Productivity

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It is time for state governments to fulfill the original promise of e-government to improve efficiency, lower costs of government services, and boost the productivity of citizens and businesses alike.

In the private sector, companies have long used information technology (IT) to work smarter and faster—constantly maximizing efficiency as they improve products and services for customers. In short, they constantly strive to increase productivity. In the public sector, e-government initiatives are supposed to work the same way. Governments are supposed to harness IT to increase efficiencies, cut costs, and improve the quality of public services. All too often, however, governments focus primarily on improving services, not on increasing productivity. Lawmakers and administrators tend to view IT as a cost center, not a strategic investment that can produce tangible payoffs for taxpayers. This is partly because increasing quality and convenience for citizens is politically uncontroversial, while cutting costs—particularly labor costs—can be. But it is time for governments, especially state governments, to fulfill the original promise of e-government to significantly improve efficiency and lower the costs of providing services. By doing so, state governments could save as much as $11 billion over the next five years.[1]

What would it look like if states were able to fully realize their potential for IT-enabled productivity? Government programs would be leaner, employing fewer workers and using fewer materials. Government services would be fully digitized, with internal processes securely accessible by employees from anywhere and external processes easily available to all citizens and businesses. Self-service would be ubiquitous, and citizens would not waste time waiting in lines to speak to government officials to complete routine transactions, such as filling out a driver's license form or completing their taxes. All government forms would be

available online to complete and submit electronically. Government agencies would share data so that users would never be asked to submit the same information twice. Government procurement systems would be flexible, transparent, and available to all businesses. Every government service, from garbage collection to traffic management, would use analytics and the Internet of Things to optimize its operations. Rates of incorporating this technology into government services would be near 100 percent. In short, government would be a highly efficient enterprise that uses technology not only to cut its own costs, but also to boost productivity for businesses and residents.

To be sure, states have begun implementing some impressive IT programs that have led to noteworthy productivity gains, both for the agencies that implement them and the citizens and businesses that use them. The question now is whether these kinds of practices can be extended to a much larger set of government practices, programs, and strategies across all 50 states.

This report investigates how IT-enabled government can increase productivity. It first makes the case for IT-led productivity in government, reviewing the literature on IT and state and local government productivity. It then provides a wide array of examples of how state governments have been able to use IT to boost productivity. The report then discusses the barriers state governments face in using IT to raise productivity. Finally, the report offers a number of recommendations to state policymakers for optimizing productivity through IT-enabled government, including:

- Adopting statewide IT-enabled productivity strategies;
- Providing state CIOs with more decision-making authority;
- Focusing on productivity rather than IT, per se;
- Setting dates by which they will no longer accept non-digital interactions;
- Accounting for external productivity gains in IT budgeting;
- Embracing e-government public-private partnerships; and
- Fostering cooperation among states on shared IT services.

The federal government can help states improve their productivity by creating incentivizes and requirements to improve state government's use of IT, particularly for its grant and assistance programs in such areas as education and health care. To do that:

- OMB should establish a process to harmonize federal agency grant requirements related to IT; and
- Both federal and state governments should create incentive programs for IT-led productivity.

THE IMPORTANCE OF GOVERNMENT PRODUCTIVITY

To understand government productivity, it is first important to understand productivity in general. Productivity is the measure of economic output per unit of input. The unit of input can either be labor hours (i.e., labor productivity) or all factors affecting production, such as labor, materials, and energy (i.e., total factor productivity). Despite this straightforward definition, many still use the term incorrectly. For example, some argue

that simply lowering wages increases productivity because it cuts costs. But while this may reduce prices, lower prices themselves do not signify increases in productivity.

In the broad sense, economies have three ways to grow over the medium and longer term: growth in the number of workers, growth in the share of activity in high-productivity sectors, and growth in productivity across-the-board.[2] First, increasing the number of workers is a non-sustainable strategy and does nothing to increase per-hour income. In the second method, the "shift effect" occurs when the mix of low- and high-productivity sectors, as opposed to firms, in a region changes. For example, if a region loses agricultural jobs (which can have low productivity) and gains the same number of software jobs (which usually have higher productivity), overall productivity increases. But for most states this effect is usually quite modest. Finally, the across-the-board "growth effect" occurs when a region's productivity increases in all sectors—both low and high productivity ones. For example, this occurs if the retail and banking sector as well as state and local governments all increase their productivity. This kind of productivity is responsible for the lion's share of economic growth in states.

Without productivity growth, states cannot get richer on a per-capita basis.

Productivity growth is important. Without it states cannot get richer on a per-capita basis. If states care at all about the size of the pie available for their citizens—and they should—then productivity growth is the most important determinant of a state's per-capita income. Productivity growth is also important because it leads to increased government revenues (or reduced government tax rates with the same level of service).[3] Finally more efficient government services can decrease costs for both businesses and citizens that use these e-services.

Estimating Potential State Government Productivity Gains

It is difficult to measure government productivity in part because there are rarely any markets for government services that can help determine the value of the output based on market prices.[4] Take, for example, law-enforcement agencies. Their effectiveness and efficiency can be measured through the number of successful enforcement actions or crimes solved. However, the true value of these public services is not only the amount of discipline meted out, but also the deterrent effect the discipline provides—a much harder effect to measure as an output, and one that may vary with the quality of enforcement actions. In short, in the absence of good output measurements, it is harder to know if state governments are making progress.

One measure is simply the number of state government employees. That number, including education workers, grew modestly relative to the overall population, from roughly 59 per 1,000 citizens in 1980 to 65 in 2008, before declining to 61 in 2011.[5] During this period, the number of non-education workers remained about the same when compared to the overall population. Between 2008 and 2012, the total number of state non-education employees declined by around 192,000.[6] This decline in state government employees can be seen in figure 1 across many state government functions, such as public welfare, transportation, police and corrections, and financial administration. Because this decline coincides with an economic recession, it is likely that it did not result from increased productivity, but rather a decline in output (i.e., cuts in state government

budgets resulted in fewer programs). Without knowing the change in government output, it is not possible to say that this reduction in state government workers reflects increased productivity. Moreover, states could have substituted contract workers or other third-party organizations to deliver state services, which would not show up in the overall labor effort. In short, it is virtually impossible to know if state government productivity has grown faster or slower than overall U.S. economy-wide productivity.

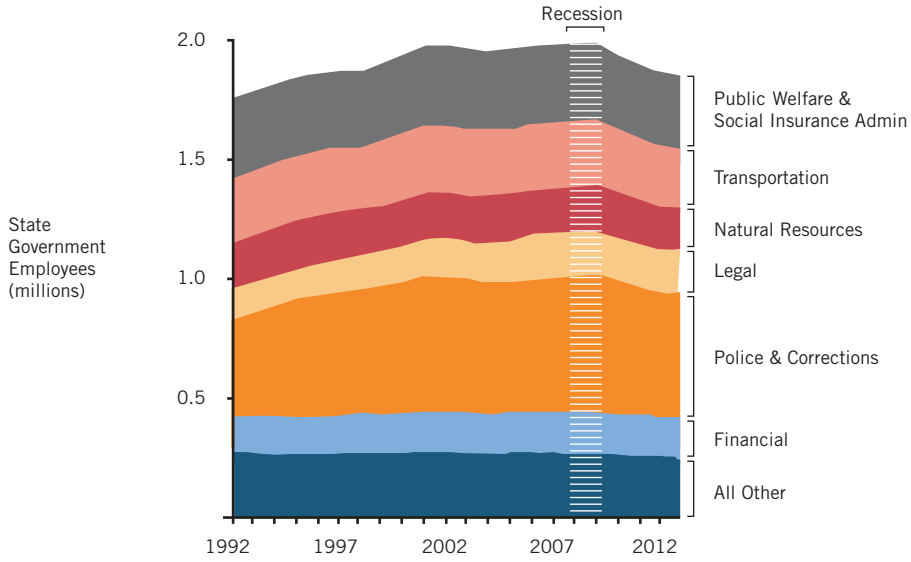

Figure 1: State government employees by function (1992-2013).[7]

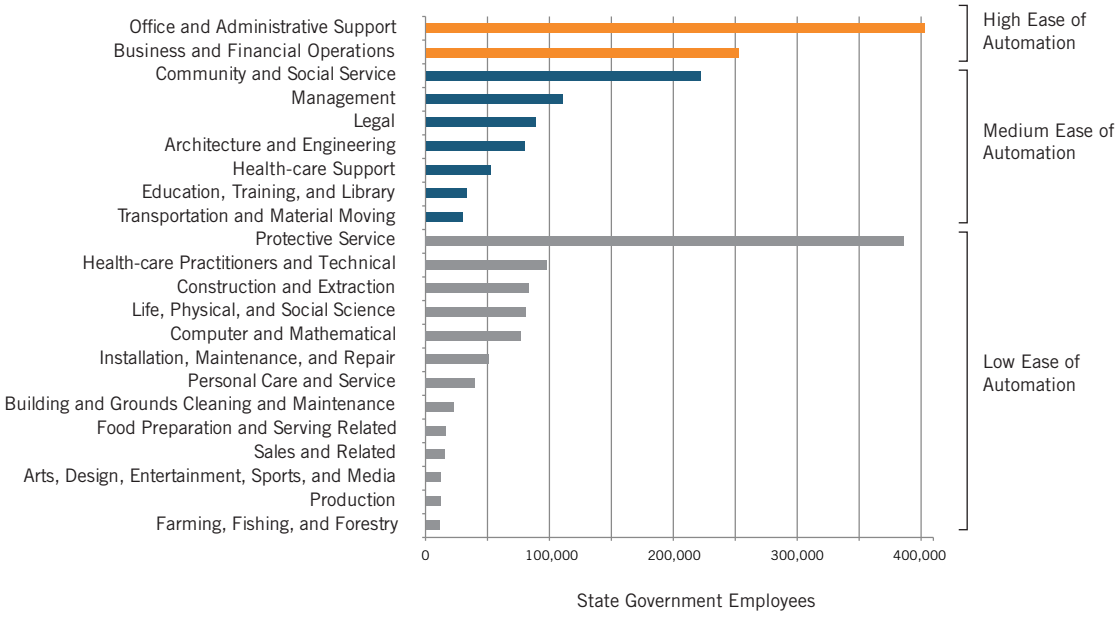

Figure 2: State government employment by occupation in 2014.[8]

Despite this lack of information, it is possible to speculate about the potential of IT to drive increased state government productivity. But the potential for productivity gains is not equally distributed within government. Based on lessons from the private sector, functions involving routine information processes are likely more amenable to productivity gains than other functions. Figure 2 breaks down state occupations by how easy it is to use

IT to automate that occupation's functions, based on three categories: low, medium, and high. In order to identify cost savings estimates from IT-enabled productivity, figure 3 includes employee costs for each category.

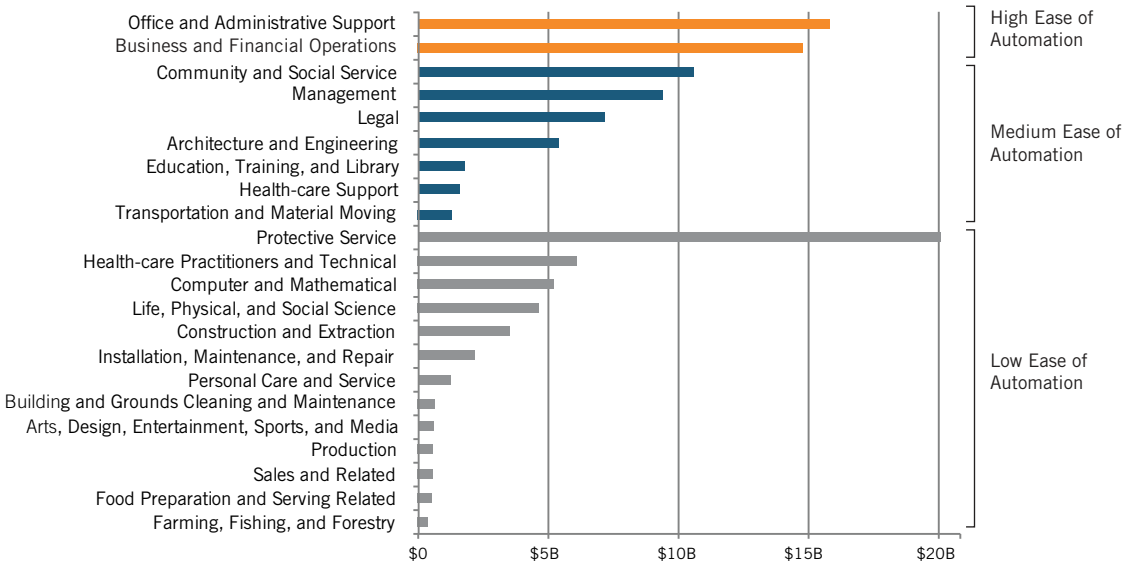

Figure 3: State governments' total employee labor cost in 2014.[9]

If IT-enabled productivity were increased by metrics outlined in this report, state governments could save approximately $11 billion over five years.

By ranking these industries by their ease of IT-enabled automation, we can now estimate labor cost savings. For these purposes, we estimate that state occupations with low ease of automation have a likely annual productivity growth of 0.5 percent, those with a medium ease of automation have a likely annual productivity growth of 2.5 percent, and those with a high ease of automation have a likely annual productivity growth of 4 percent.[10] To compare that to other industries, from 2009 to 2014, overall U.S. business sector labor productivity growth was 1.5 percent per year.[11] If state government productivity was increased by these metrics, state governments could save approximately $2.4 billion each year, with total estimated savings over five years of over $11 billion (see figure 4).

State Government Occupations	Employee Costs	Savings Factor	Savings
Office and Administrative Support	$16,274,535,000	4.00%	$650,981,000
Business and Financial Operations	$14,831,542,000	4.00%	$593,262,000
Community and Social Service	$10,575,090,000	2.50%	$264,377,000
Management	$9,367,156,000	2.50%	$234,179,000
Legal	$7,127,803,000	2.50%	$178,195,000
Architecture and Engineering	$5,394,073,000	2.50%	$134,852,000
Education, Training, and Library	$1,776,584,000	2.50%	$44,415,000
Health-Care Support	$1,592,188,000	2.50%	$39,805,000
Transportation and Material Moving	$1,328,374,000	2.50%	$33,209,000
Protective Service	$20,086,095,000	0.50%	$100,430,000
Health-Care Practitioners and Technical	$6,108,951,000	0.50%	$30,545,000
Computer and Mathematical	$5,234,564,000	0.50%	$26,173,000
Life, Physical, and Social Science	$4,659,136,000	0.50%	$23,296,000
Construction and Extraction	$3,515,724,000	0.50%	$17,579,000
Installation, Maintenance, and Repair	$2,175,550,000	0.50%	$10,878,000
Personal Care and Service	$1,253,733,000	0.50%	$6,269,000
Building and Grounds Cleaning and Maintenance	$671,179,000	0.50%	$3,356,000
Arts, Design, Entertainment, Sports, and Media	$607,551,000	0.50%	$3,038,000
Production	$588,869,000	0.50%	$2,944,000
Sales and Related	$587,713,000	0.50%	$2,939,000
Food Preparation and Serving Related	$548,949,000	0.50%	$2,745,000
Farming, Fishing, and Forestry	$389,850,000	0.50%	$1,949,000
Total	**$114,656,710,000**		**$2,405,416,000**

Figure 4: Potential savings from productivity gains over one year in U.S. states.[12]

Figure 5 is a breakdown of potential savings from IT-enabled productivity across all U.S. states, from California, which could see savings as high as $1.3 billion to South Dakota, which could see savings as high as $38 million.

State	Cost Savings	State	Cost Savings
Alabama	$147,535,000	Montana	$65,026,000
Alaska	$117,795,000	Nebraska	$50,565,000
Arizona	$177,587,000	Nevada	$96,363,000
Arkansas	$138,575,000	New Hampshire	$48,095,000
California	$1,329,017,000	New Jersey	$584,172,000
Colorado	$173,855,000	New Mexico	$84,877,000
Connecticut	$248,085,000	New York	$788,930,000
Delaware	$88,054,000	North Carolina	$277,964,000
Florida	$472,227,000	North Dakota	$41,487,000
Georgia	$255,054,000	Ohio	$281,014,000
Hawaii	$101,440,000	Oklahoma	$159,409,000
Idaho	$64,266,000	Oregon	$215,632,000
Illinois	$425,422,000	Pennsylvania	$391,857,000
Indiana	$137,917,000	Rhode Island	$76,433,000
Iowa	$131,590,000	South Carolina	$145,934,000
Kansas	$78,512,000	South Dakota	$38,380,000
Kentucky	$169,836,000	Tennessee	$194,756,000
Louisiana	$148,571,000	Texas	$662,504,000
Maine	$59,373,000	Utah	$113,596,000
Maryland	$303,210,000	Vermont	$48,186,000
Massachusetts	$403,463,000	Virginia	$216,765,000
Michigan	$286,751,000	Washington	$343,881,000
Minnesota	$215,050,000	West Virginia	$88,294,000
Mississippi	$93,646,000	Wisconsin	$168,174,000
Missouri	$183,381,000	Wyoming	$41,345,000
Total			**$11,173,850,000**

Figure 5: Potential savings over five years from IT-based productivity gains in U.S states.[13]

THE ROLE OF IT IN GROWING GOVERNMENT PRODUCTIVITY

Economists have found that IT has been a key enabler of private sector productivity in the United States. However, the scholarly research on IT-enabled productivity in government is less well developed and remains tilted toward theoretical work, with limited empirical analysis. Most empirical studies focus primarily on the dynamics of government IT adoption, rather than the productivity impact once IT has been deployed. Complicating matters further, government agencies do not work in a vacuum, and the productivity benefits of IT adoption occur on multiple fronts: at the intra-agency level, at the inter-agency level, at the government level, and at the user level.[14] For example, at the intra-agency level, the adoption of new IT systems allows automation of various tasks; at the inter-agency level, communication technologies and synchronized databases lower the transaction costs incurred when agencies work together; at the government level, system-wide rollouts such as the United Kingdom's single online digital platform increase overall access and streamline various procedures; and at the user level, e-government generates savings for individuals and organizations interacting with government. [15] But individual time savings are not included in measured productivity, and business benefits would be measured as increases in business productivity, even though the savings were enabled by e-government.

On average, a $1 increase in per capita IT budget can lead to $4.18 in state government productivity gains.

Public sector metrics fall short of even the imperfect methods used to measure private sector productivity. Instead, empirical productivity analysis in the public sector has relied on surveys and the occasional publically available performance data. McKinsey & Company, a global management consulting firm, analyzed the data available on public sector productivity compared to private sector productivity using data produced by the Bureau of Labor Statistics until it stopped collecting this information in 1994.[16] The study found that productivity in both the public and private sectors rose in tandem and at the same rate until 1987. At that point, the private sector's productivity rose at a rate of 1.5 percent annually until 1994 and 3 percent until the mid-2000s, while the U.S. public sector only rose at a rate of 0.4 percent until 1994. It is important to note this measurement is of the U.S. public sector as a whole, including the federal government. After 1994, there has been little data on government productivity.

Empirical Studies of the Effect of IT on Government Productivity

Despite this, a number of studies show that government investments in IT boost productivity.[17] Several studies have evaluated the impact of IT use by comparing its impact across similar agencies. A 1996 study looked at the use of computers in federal agencies and found that agencies that adopted 10 percent more computers than the mean experienced 2.5 percent higher productivity growth.[18] Similarly, a 2012 study that examined all 50 states found that IT investments effectively increased economic performance of those states.[19] Another found that all things being equal, on average, a $1 increase in per capita IT budget can lead to $4.18 in state government productivity gains.[20] A third study found that every $1 increase in IT spending by a state CIO led to as much as a $3.49 reduction in overall state expenditures.[21]

In a comprehensive study of 24 Organisation for Economic Co-operation and Development (OECD) countries, Corsi and D'ippoliti find that "according to our

estimates, investments in ICT may have contributed positively to productivity growth in the public sector, and may have done so more effectively and significantly than other public investments have. As one would expect, both forms of investment seem more relevant in the medium-to-long run."[22] They find that IT investments generate the greatest gains to productivity after three years.[23] Another study finds that IT investments result in their most effective government cost savings after two years.[24] Such a time horizon for IT investment maturity could reflect the time lag necessary to get employees accustomed to, familiarized with, and using such IT improvements effectively.

Other studies confirm that e-government needs to be accompanied by organizational change and innovation backed by good management in order to maximize the productivity benefit.[25] In a study of police departments across the United States, Garicano and Heaten find a significant effect of IT use on departmental productivity only when IT use was "complemented with particular organizational and management practices."[26] These findings are similar to private-sector findings that show that getting the most out of IT requires innovative management and reorganization.[27] At least one empirical paper examining police departments found no effect from IT use; however, it is unclear whether better analysis of the interaction between management and IT use would reveal more productivity growth.[28]

Other work has looked at the impact of e-government on private sector economic growth. One study found that state government investment in IT, both measured in terms of financial and technical performance, caused an increase in gross state output.[29] In a study on IT investments and state general fund expenditures, Pang found a causal relationship between the two factors, estimating that a "$1 increase in per capita IT budget is associated with a $3.88 reduction in per capita general expenditure."[30] On a smaller scale, one study showed that adoption of county websites in the Los Angeles basin area positively affected local economic development, such as by increasing the personal income per capita by providing information that local businesses needed; reducing transaction, coordination, and information costs; and allowing stakeholders to collaborate through information sharing.[31]

Despite the productivity potential of IT, many governments have yet to achieve their full potential. This is apparent from available survey data. To be sure, differences between 2004 and 2011 surveys of local U.S. governments show that they have made continued progress.[32] For example, the number of departments reporting that IT has increased efficiency of business processes or reduced administrative costs has grown. Still, these surveys clearly show that many local governments are not taking full advantage of IT's transformative impact. In 2011 the large majority of governments had used IT to improve customer service and communication with the public, but only half had used IT to increase business process efficiency, and only a third had used IT to fully reengineer business processes.[33] A 2004 survey of 47 EU cities and regions found that IT had been able to increase customer satisfaction and flexibility, and had some benefits for reducing costs and increasing efficiencies, but that most IT implementations at the time were focused on a "narrow concept of e-government."[34]

How IT Can Boost Government Productivity

IT can help boost government productivity in at least five ways. First, IT can reduce nonlabor inputs, such as by cutting material costs. Some governments cut material costs by automating processes, making their energy usage more efficient, or using telework solutions to reduce vehicle and fuel costs. For example, California's prison system uses telehealth devices to reduce the number of inmate medical trips, reducing costs related to gas and vehicle maintenance and increasing safety.[35] By offering self-service systems that allow residents or businesses to submit information electronically, government agencies can cut down on paper forms and mailing expenses, in addition to saving time.

Second, IT can reduce labor input by either enabling workers to be more efficient or to completely substitute an IT process for the worker. In some cases these changes make internal operations more efficient. For example, Michigan automated much of its HR management system, allowing employees to fulfill most of their own HR needs online.[36] In other cases, government IT can make citizen- or business-facing operations more efficient, and reduce labor input of both government and nongovernment employees. For example, Arkansas employs a self-service web portal for businesses to complete more than 500 services online, reducing its employee costs.[37]

Third, IT can reduce government costs by redu cing waste, fraud, and abuse. For example, New Mexico uses an advanced fraud detection system to identify irregularities in its unemployment insurance program.[38] Similarly, Massachusetts uses predictive modeling to detect fraud in its Medicaid program, known as MassHealth, which is an integrated system that uses algorithms to analyze all claims when they enter the system. Since its launch in 2013, the state has realized more than $10.5 million in cost savings by preventing errant payments and post-payment recoveries. In its first year, MassHealth helped recoup its $6.9 million cost (most of which came from federal funds).[39] To the extent these payments were for unnecessary services or enabled people to stay out of the workforce longer, they boosted productivity.

Fourth, governments can increase the efficiency of their IT investments through actions such as replacing older equipment with lower-cost technology, consolidating data centers, digitizing paper-based workflows to eliminate printing costs, or moving to cloud-based services. For example, in 2014 Texas implemented a cloud-based procurement system that replaced its legacy system, cutting maintenance costs from $11.5 million annually to under $3.3 million.[40] The total cost of this upgrade was $2,972,700 for subscription service licenses and development time, and $185,900 in personnel costs.

Finally, government agencies can increase productivity by improving service quality. While this may not lead to reduced inputs, by definition higher quality services result in increased output. For example, Idaho uses a secure mobile payment processor enabled by Android-based smartphones to take secure mobile payments in the field, increasing citizen convenience and the security of each payment.[41]

The focus of this report will largely be on the first two sources of government productivity listed above: increased efficiency in labor and nonlabor inputs. The report will not concentrate on modernization efforts; quality improvements; or waste, fraud, and abuse reduction. Indeed, the focus of the report is not in how to boost IT efficiency—although that can be important if overall IT investments are increasing—but rather how to use IT to cut other government costs.

Technologies to Boost Government Productivity

Governments have a wide array of tools that they use to cut employee and material costs and boost the productivity of their businesses and citizens. This section will explore some of the functions IT can streamline.

IT to Replace Person-to-Person Tasks

State governments can increase their productivity by substituting technology for an employee, such as self-service tools offered over the Internet, mobile devices, or kiosks.

One way state governments can increase productivity while decreasing employee costs is to substitute technology for employees, therefore eliminating the need for a person to execute a service. Much of this use of technology involves self-service tools on the Internet, via mobile devices, or at kiosks. For example, Michigan's "MI HR" program allows its employees to view earnings statements, change their insurance benefits, add and remove dependents, and access other information from human resources, all while cutting the state's related employee costs.[42] Arkansas partnered with the company NIC to establish kiosks at its Department of Finance and Administration buildings to streamline the vehicle registration process, removing the need for employees to greet customers and take payments.[43] The kiosk system streamlines the process and reduces wait times, allowing employees to optimize their time. Similarly, Utah moved many of its services online, such as renewing a car, ordering birth certificates, and filing taxes, reducing the need for person-to-person interactions between state government and its residents, and saving an estimate $46 million.[44]

IT to Replace Routine Staff Tasks

Governments can also use IT to reduce their material and employee costs by eliminating routine tasks, such as manual entry of paper forms. States can use a variety of technologies to capture information electronically, such as online applications and smart, connected devices. For example, Arkansas offers an automated corporation filing system that allows businesses to submit forms electronically, eliminating the need for paper copies and manual data entry.[45] This saves more than 2,064 employee hours annually due to manual entry and approximately 72,144 sheets of paper each year. Similarly, before going digital, California's Department of Corrections and Rehabilitation (CDCR) used to maintain a file with each inmate's paper records, some of which were large enough to be stored in boxes.[46] Each time CDCR transferred an inmate, its employees had to ship that inmate's files to the next prison. With over 137,000 inmates in CDCR's care and hundreds of transfers a year, this situation led to a complicated and costly system. By automating the files in its Strategic Offender Management System, CDCR saved over $500,000 in paper costs and $1 million in storage costs annually, not to mention eliminating unnecessary staff tasks and reducing errors associated with the old paper system.[47]

States can also use mobile apps to streamline tasks. For example, Colorado uses a mobile app to replace manual paper entry and better track at-risk adults in its Adult Protection Services Program (APS).[48] This application has allowed staff to reduce the time it takes to complete a report by nearly 20 minutes each because they no longer have to manually enter paper reports. As a result, APS has experienced a 40 percent increase in the number of cases it can address.

IT to Optimize Performance

Governments can also use IT to optimize the performance of their programs. For example, Utah has placed thousands of sensors along its highways to help monitor road conditions throughout the state during inclement weather. This helps the state put road crews where they are most needed.[49] Similarly, Oregon implemented an active traffic management program that uses sensors to automatically measures speeds, traffic flows, and congestion. The state uses this information to predict traffic flows, monitor the weather, and alert drivers in real time to their estimated travel times. By monitoring its highways, Oregon has increased the efficiency of its road crews, and reduced the number of crashes.

Governments collect a lot of data through their many multifaceted programs—whether it is tax data, water usage data, or license data. Recently, governments have started to see the value of this information to analyze trends and adjust programs. This saves costs and boosts efficiency by identifying shortcomings and opportunities to improve services. For example, Indiana's data infrastructure uses analysis to tackle a variety of state's problems.[50] When the state discovered that its infant mortality rate was higher than the national average, Indiana consulted its data infrastructure to identify risk factors associated with the problem, and the legislature used this information to fund a solution.

CASE STUDIES

Virtually all states have been able to implement at least some IT projects that increased the productivity of their services while cutting waste and eliminating workforce and material costs. And for applications that are outward-facing, states have also cut costs of businesses, other organizations (e.g., local governments), and citizens that interact with the state government. The following section examines 10 case studies in which state governments have used IT to increase productivity.

Indiana Uses Big Data to Reduce Infant Mortality

In March 2014, Indiana Governor Mike Pence instructed state agencies to collect and share data with the Office of Management and Budget (OMB) and the Office of Technology (IOT) to improve state services and programs.[51] Pence realized that sharing data, and the insights the state could glean from analyzing that data, could lead to cost savings and solutions to complex problems. Indiana publishes data for 60 agencies to a public-facing website, the Management and Performance Hub (MPH), with key performance indicators (KPI) and an interactive dashboard, which helps the state identify trends, shortcomings, and opportunities to improve programs and services.[52] The software for Indiana's MPH cost the state $2.5 million, with an annual $550,000 maintenance fee.[53] However, the state hopes to use this data analytics engine to tackle its most salient problems, such as the state's infant mortality rate, recidivism, and associated costs. This

technology allows inquiries that once took hours to take only minutes, and state reports that once took a month to prepare now take 30 minutes.[54] This investment in IT infrastructure and analytics has also allowed Indiana to address a number of issues in creative ways, such as using civic hackathons to track high density car accident zones. One winner of the Indy Civic Hackathon developed a platform to prioritize public and private investment into community revitalization by calculating reinvestment scores based on key metrics from publically available data.[55]

The state uses MPH for more than just budgeting, but also to save lives. Indiana employed this new data infrastructure to tackle the state's infant mortality rate. As of 2013, the infant mortality rate in the state was 7.7 deaths per 1,000 births—slightly higher than the national average.[56] Indiana's goal was to get this rate below the national average by 2016. The state asked the MPH team to compile data from 17 integrated data sets from five agencies and four public sources and then pool information about conditions that may influence infant health.[57] The MPH gathered information, including demographics, health, financial, and criminal history, insurance, and other potentially relevant data.[58]

The MPH team found that inadequate prenatal care, Medicaid enrollment, and young maternal age were the strongest predictors of infant mortality.[59] More importantly, they found that "while the identified high-risk subpopulations account for only 1.6 percent of all Indiana births, they account for nearly 50 percent of infant deaths."[60] This data-fueled insight helped the State Department of Health secure funding and tailor its programming to at-risk populations. The data was presented to Indiana legislators, who allotted $13.5 million in funding to support programs such as the Labor of Love campaign, which raises awareness about infant mortality and connects the public with related resources.

Indiana's effort to save infants' lives reduced costs. It costs two to three times more to care for babies born under 2,500 grams than for babies born at a healthier weight.[61] Taxpayers will realize these cost savings over time as programs are targeted to at-risk groups and there are more healthy deliveries. The infant mortality prevention project was one product of Indiana's data-gathering system that can be used for similar projects, such as combating drug abuse, which may result in even greater cost savings for the state.

Pennsylvania Uses a Mobile Application to Improve Road and Construction Inspections

The Pennsylvania Department of Transportation (PennDOT) maintains over 40,000 miles of road and 25,000 bridges.[62] One-quarter of these roadways are weight-restricted and require weekly inspections by PennDOT inspectors when companies request access to transport heavy equipment.[63] When a company requests the use of a state highway to haul heavy equipment, the state conducts a survey on the "posted and bonded" roadway to chart any damage to that road and conduct repairs if needed. The costs of these detailed inspections are then passed along to state businesses, such as oil and gas companies that use the roads for transporting their products. Prior to 2013, inspectors conducted these surveys on paper and used digital cameras to capture road and bridge conditions. They returned to the office weekly to enter the survey data manually into the database and store copies of the digital pictures they took in filing cabinets. Because of this slow, paper-based process, inspectors spent more time on administrative work than conducting surveys in the field.

In January 2013, PennDOT implemented a mobile application to streamline weight-restricted road and bridge inspections. Inspectors can now enter data and photographs into the mobile application as they collect it. The mobile application uses cellular and Wi-Fi connections to transmit data to PennDOT's roads and bridges management databases. Data may also be entered and stored offline, which allows inspections in the most remote locations. All data is transmitted in real-time once a connection is established, making daily reporting feasible.

The mobile application saves time and reduces the likelihood of data entry mistakes. PennDOT estimates that inspectors save about 10 to 15 minutes per survey, which translates to three to four hours of time savings in administrative work each week. This amounts to roughly 6,000 hours saved each year and a total savings of approximately $550,000 in personnel hours during 2013.[64] Pennsylvania has used this cost savings to increase business productivity. The state reduced the cost of inspections from $13.49 per mile to $10.80 per mile, passing along over $500,000 in savings annually to companies that pay to use posted and bonded roads.[65] By using a centralized system, the state was also able to make its inspection processes more transparent and open. Citizens and bond posters enjoyed increased efficiency in their ability to view real-time inspection data from Pennsylvania's public website.

The success of this project spurred Pennsylvania's further adoption of mobile services. PennDOT created a statewide Center for Excellence for Mobile Device Management to enable other state agencies to leverage its expertise for new mobile solutions.[66] PennDOT saw the number of active construction projects jump from 566 projects in 2013 to 832 projects in 2014. PennDOT added functionality to the Mobile Highway Construction App to accommodate this increase, giving access to construction inspectors who verify all materials delivered, verify work completed by contractors, and document other inspection and quality assurance activities.[67]

PennDOT estimates that construction inspectors saved over 62,000 hours in 2014, for a total savings of almost $2.3 million.[68] The app will be rolled out to 1,200 more inspectors in 2015, and PennDOT expects the state will save over 379,200 person hours each year, or more than $17.5 million.[69] By using the mobile application, inspectors spend 92 percent of their time on inspection activities, compared with 75 percent before the mobile application.[70] These productivity gains also transferred to the construction community. Consultant inspectors saw cost savings in the amount of $150 per person per year through the reduction of hard copy documentation.[71] In addition, due to electronic routing replacing the standard purchasing, printing, and shipping of reference documents for construction jobs, contractors saved roughly $274,000 in 2014 alone. In total, the state predicts this project will realize $18 million per year in operational efficiencies, including the cost of the program, savings, and value-added inspection activities.[72] Indeed, this use of a mobile application resulted in tangible benefits for both the state and the transportation construction community.

Montana Saves $3.4 Million Over a 5-Year Period by Automating Four Service Transactions

Montana's online presence began in 2001 with 11 online services. It has since grown to a suite of over 300 online services, processing 10.7 million transactions each year across 23 state departments and agencies.[73] Montana estimates that it saved approximately $3.4 million over a five-year period (July 1, 2009 to June 30, 2014) by switching just four of its services to an online delivery method.[74] These direct cost savings are calculated primarily from a reduction in associated personnel and material costs required to manually process paper-based transactions.

The secretary of state switched to an automated process that allowed Montana-registered businesses to file their annual reports online in 2005. Over a period of five years, the Business Entity Annual Report service saved the state over $1.5 million by reducing the cost of manual processing by $3.05 per transaction.[75] Because of this efficiency, Montana was able to reduce the number of temporary workers it hired to enter yearly reports. This change also generated productivity gains for Montana businesses. Prior to online filings, customers had to file their reports by paper in the secretary of state's office, with lengthy wait times for businesses.[76] At the time of implementation, the secretary of state's office charged customers $15 to file their annual report by paper and $10 to file it online.[77] This resulted in cost savings for businesses over the next decade.[78] Furthermore, 78 percent of users report that the online services make it easier to conduct business in Montana, and 74 percent of users agree that the services are business-friendly.[79]

In 2002, the Montana Department of Corrections implemented the Correctional Offender Network (CON), which provides the public with real-time information about adult convicted felons, including criminal record, sentence, physical description, and photo.[80] The CON online service allows users to look up information about convicted felons without human interaction. The portal automatically processed nearly 75,000 inquiries between 2009 and 2014, saving the state over $1 million in personnel and material costs associated with manual entry.[81] The system was updated in 2015 to allow users to get this information in real-time and on their mobile devices, saving them additional time.[82]

The Montana Department of Justice instituted the Temporary Registration Permit service that allows citizens to quickly register a new vehicle online. This service saved the state approximately $165,000 over five years by processing 238,617 transactions electronically.[83] Similarly, the Department of Fish, Wildlife, and Parks automated its licensing system. During the same five-year period, the state saved $645,885 by processing over 1.5 million hunting and fishing transactions online.[84] Both of these licensing systems saved time and money for citizens who could perform transactions online rather than wait in line at a state office. Both online services can also disseminate public notices and renewal reminders more efficiently to license-holders and keep them up-to-date on relevant news and information.

The savings to the state across these four departments are significant, but user benefits are also valuable. In a 2014 survey of 500 users of Montana's online services, 94 percent report that online services saved them time, and 92 percent report the services as reliable.[85] Furthermore, by using a self-funded approach—where a private firm supplies the service

with a small fee worked into the system so that it pays for itself, Montana was able to implement these services without increasing its budget request.[86]

Virginia Automates Its Procurement Process and Uses Mobile Apps to Increase Efficiency

Before 2001, the Commonwealth of Virginia used a manual procurement process that was time consuming and costly, and limited suppliers to selling to only to the agencies they personally knew. Firms hoping to do business with Virginia's government faced many challenges. First, they had to physically travel to each agency and university purchasing office to register as a vendor to simply see what opportunities were available. Alternately, vendors could join a mailing list for $75 and receive a periodic listing of business opportunities for projects costing $30,000 projects or more.[87] This created a barrier to smaller businesses looking for more affordable opportunities to grow. When a contract was secured, suppliers had to distribute paper catalogs to possible buyers, and if anything changed price, suppliers had to communicate the change to each state agency separately.[88] Each purchasing office had its own processes, creating inconsistencies in the information given to suppliers, and leading to frequent returns and corrections that caused delivery delays. Also, because everything was paper-based, businesses found it difficult to automate internal processes to increase their own productivity.

In 2001, Virginia implemented the eVA program, a virtual enterprise-wide procurement system that connected all agencies, higher education institutions, and local governments that all stakeholders could access through a single portal.[89] eVA automates workflows and establishes rules and standards for buyers, while collecting and aggregating procurement data and activity to create a transparent and auditable system. Suppliers are able to register through a self-service portal on eVA, which is more convenient for both users and eliminates the need to for each agency to duplicate the supplier's information. Suppliers submit electronic catalogs to the virtual marketplace, where state organizations can immediately place orders. Suppliers can track contract opportunities and previous transactions. Officials can generate solicitations inside the system, and notify vendors by email about new opportunities. The entire procurement process—from bidding to managing purchase orders to evaluation and reporting—is electronic.

The eVA has provided a number of benefits to state agencies and businesses. As of August 2014, Virginia reports that $37 billion dollars in purchases were generated through the system and made immediately visible to the public.[90] State organizations are able to find opportunities to collaborate and leverage buying power to save money. It costs the state $10 to $15 to automatically process purchases, compared with an estimated $125 price tag for manual purchases.[91] Since Virginia completes over 450,000 purchases each year, even a cost reduction of only 50 percent of this estimate would produce an annual savings in administrative costs of roughly $22 million.[92]

eVA has significantly increased business competition, allowing more small businesses to participate and reducing prices for buying agencies. The increased competition saved state agencies approximately $30 million in 2014.[93] This system also created productivity gains for businesses interacting with government. Suppliers' delivery time has improved by 25 percent, and the time from solicitation to award has decreased by 70 percent.[94] Suppliers

now receive all orders in a standard format, reducing the number of errors and increasing turnaround time. This efficiency has likely given these businesses the ability to further cut both employee and material costs, resources that would have been tied up in the previous manual outreach and paper system.

The success of eVA over the last decade and the growing use of mobile technologies prompted Virginia to launch two eVA mobile apps. eVA Mobile 4 Business connects real-time business opportunities to suppliers through a mobile platform.[95] Businesses can view government procurement opportunities and check on their bids in real time, from their mobile devices. The eVA Mobile Approvers a pp gives eVA government approvers real-time access to procurement details, such as buyer information, on their mobile devices. Information timeliness is a critical factor in purchasing decisions, because agencies often have a limited window in which to acquire goods or services, and businesses have a limited amount of time to submit bids. By ensuring that there is no divide in the amount or timeliness of information given to applicant vendors, mobile apps increase competition for businesses, which will in turn lower prices for government.

Ohio Uses Self-Service and Sharing Initiatives to Cut Costs and Improve Services

Like many other states, Ohio recognized the need to transform IT statewide to improve service to citizens. As recently as 2013, most of the state's 26 cabinet agencies and over 70 boards and commissions managed their own IT efforts.[96] Similarly, many state programs were administered at the county level, and program standards differed significantly from county to county.[97] Under this governance model, counties had autonomy to deliver state-appropriated services—such as those that deliver cash, food, and medical assistance benefits to citizens—but were restricted from sharing data across county lines because of disparities in their IT infrastructure and data collection methodologies.

To remedy the IT redundancy and lack of collaboration between county and state governments, Ohio launched an IT transformation program in 2013. The program cost the state $1.9 million over three years, and aimed to reduce the number of full-time IT professionals by 400 through attrition and retirement, and make service delivery more efficient through cross-boundary collaboration and self-service.[98] Ohio plans to reach these goals by expanding private cloud infrastructure, encouraging enterprise shared solutions, and improving online government services.[99]

One of Ohio's first modernization projects in this effort began in early 2013 in response to the changing health-care landscape that extended Medicaid coverage to an additional 275,000 residents.[100] The Office of Health Transformation (OHT) launched the Integrated Eligibility (IE) system to simplify and expedite eligibility determination for multiple Health and Human Services programs and enhance the ability of state and local entities to work together.[101] The first release of the IE system rolled out in October 2013 to citizens eligible for early enrollment based on their modified adjusted gross income. The second phase, which is scheduled to begin in September 2015, will extend access to this program to other users of Medicaid and similar income-based benefits programs.[102]

The IE system has the capacity to give 300,000 users access to health and human services programs through a self-service portal called benefits.ohio.gov.[103] It integrates with various

federal agencies' databases—Homeland Security, Social Security, Internal Revenue Service, Medicaid, and Medicare—to enable real-time data verification and eligibility determination. As of 2014, the IE system supports 2.3 million Medicaid recipients and 20,000 caseworkers across 88 counties. Since its rollout, the IE system has handled over 400,000 applications, approximately 15 percent of which were processed without case worker intervention.[104]

Given the success of the IE project, the state then launched additional initiatives to improve access to Medicaid benefits using the benefits.ohio.gov website. In January 2014, the Ohio Department of Rehabilitation and Corrections and the Ohio Department of Medicaid (ODM) launched a joint venture to help offenders apply for benefits prior to their release.[105] The aim of the program was to provide continued health care for offenders after reentry, with the hopes of reducing recidivism rates.[106] Access to treatments, especially mental health and substance abuse services, is critical to successful reentry and improved health outcomes. In the long term, reduced recidivism rates save tax dollars spent on a high incarceration rate.

California Corrections Uses Telehealth to Cut Material and Employee Costs

California's Department of Corrections and Rehabilitation (CDCR) has 35 institutions, 137,000 inmates, and 60,000 parolees, managing a vast amount of information for a large number of stakeholders. Because California prisons are spread out in rural areas over a large state, health care can be a difficult challenge. At rural prisons, health-care specialists are often in short supply, and physicians do not normally choose to locate permanently in the area. Thus, there are high turnover rates for prison physicians, which increased training costs for CDCR's health-care organization, called California Correctional Health Care Services (CCHCS), and created a need for inmates to be physically transported to specialists. This travel was long and expensive, given that the price of gas had jumped to $4 a gallon.[107] To fix the problem, CCHCS employed telehealth solutions to decrease costs and get inmates the care they needed.

By 2004, California had installed telehealth equipment in a number of its prisons, but only five accounted for roughly 60 percent of the state's telehealth consults.[108] In fact, at that time, nine of the prisons outfitted with this equipment did not use it and thus did not receive any cost benefits. Then in 2009 CCHCS aggressively expanded its telehealth program to get its rural prisons connected to specialty health care, developing a strategic plan to better coordinate these efforts.[109] This program contracted private health-care entities throughout the state to provide corrections staff with remote access to medical specialists, and in the case of emergencies, it allowed inmates to get an evaluation without a transfer. This program allowed prison staff to collaborate with over 7,000 health-care staff, including doctors, nurses, and pharmacists.

The CCHCS telemedicine program uses 81 telepresence endpoints to connect staff and patients to specialists through video, audio, and other sensory technologies, such as stethoscopes.[110] It set up endpoints at correctional institutions that linked to endpoints at physicians' offices throughout the state, using high-resolution cameras and audio equipment to allow physicians to communicate directly with patients.[111] By 2012,

California had set up these stations in 33 of its prisons, serving an approximate population of 166,000 inmates.

This program resulted in a 21 percent increased number of inmate medical encounters in its first year, because inmates had easier access to medical care.[112] By 2012, more than 50 percent of California's correctional facilities conducted their specialty health-care encounters through telemedicine. Not only did this program enhance public safety—when appropriate, inmates no longer need to be transported off prison grounds for health care—but it also reduced CDCR's material costs related to security, gas, and vehicle maintenance. In fact, CDCR estimated that telemedicine saved the state an average of $850 per trip.[113]

Oregon Department of Transportation Uses Digital Signs to Decrease Traffic

The highway that runs through the southwestern suburbs of Portland, Oregon, known as Route 217, serves an average of over 115,000 vehicles per day.[114] This highway is prone to dense traffic with nine closely spaced lanes that often contain entering and exiting traffic, particularly during rush hours. In the last three decades, traffic on this busy thoroughfare has more than doubled, resulting in reduced mobility, decreased safety, and increased wait times for motorists. Indeed, this freeway's crash rates and congestion were higher than the national averages. As the Oregon Department of Transportation (ODOT) reports, the majority of motorists were forced to rely on past experience and proximity of the traffic in front of them to estimate traffic incidents.

To address this problem, ODOT implemented the Active Traffic Management (ATM) project in fall 2012, which measures speeds, traffic flows, and congestion, using this information to alert drivers in real time about travel times. The system uses a variety of input data from road sensors that detect volume, occupancy, and speed, as well as weather and highway traveler condition databases. The fully automated system calculates traffic and weather-based variables, congestion warnings, advisory speeds, and travel times to common destinations. The system was part of a $20 million project to improve the corridor. [115]

The system benefits both citizens and business es by communicating upcoming congestion. Highway signs relay the system's information, so drivers can keep their eyes on the road, and can consider alternative routes or adjust their schedules to better plan their destination arrival times. The system also regulates the flow of traffic, which keeps traffic moving more rapidly during peak operation. This has led to reduced travel times for drivers. Peak traffic hours during mornings and evenings have decreased by 9 percent, while midday travel times experienced between 8 and 18 percent reduction.[116] This adds up to an average time-savings of 18 minutes for drivers on Route 217. Furthermore, the highway's time variability—the range of time that the route could take to travel—decreased by 50 percent. As a theoretical example, if a ride took between 10 and 30 minutes to travel before, that ride would take between 5 and 15 minutes after the ATM was introduced. This amounts to over $116 million in savings a year for drivers.[117]

The ATM system also reduced traffic accidents. In 2010, Route 217 had a crash rate of 0.66 per million vehicle miles, with approximately 200 crashes per year.[118] Early studies indicate that, in November 2014, during winter weather conditions, the number of crash-related incidents decreased by 25 percent.

Utah Transit Authority Uses Highway Sensors to Lower Its Weather Response Costs

In winter, Utah drivers can experience large quantities of snow and ice. To protect the population and decrease its upkeep costs, Utah has placed thousands of sensors along highways to help monitor road conditions throughout the state. The Utah Department of Transportation, the state agency in charge of these efforts, sought to use technology, data analytics, and the Internet of Things to help optimize these services while lowering costs.

The Department's Winter Road Weather Index (WRWI) is a real-time tool the state uses to monitor storms, evaluate their intensity, study the accumulation of snow on roadways, and assess the effectiveness of snow removal efforts. All of WRWI's data comes from sensors installed next to roadways called Road Weather Information System (RWIS) units.[119] These sensors gather data on multiple environmental factors, such as precipitation, road temperature, friction on the roads, air temperature, and wind speed. These RWIS units also have pole-mounted infrared sensors that scan the road, allowing personnel to gauge the surface of the road by analyzing light reflected from snow and ice.[120] By 2014, Utah had expanded its number of RWIS sites collecting data with specialized sensors from 16 to 71.[121] The department uses these sensors to expedite snow removal, as well as optimize its use of materials and labor.

Not only do these sensors help with large winter storms, Utah also uses them to respond to flooding, landslides, and other natural disasters. In the summer of 2012, a wildfire burned 10 miles of steep terrain in Huntington Canyon along the Utah State Route (SR) 31 highway.[122] In 2013, Utah deployed a RWIS sensor in the area to collect weather data and monitor the at-risk region. The sensor moni tored for excess flooding, allowing the department to provide continual updates to the public during storms. By monitoring this information, Utah shut down the highway prior to every debris flow in the region in 2013. As a result, there were no injuries, fatalities, or equipment losses in that period of time, and the department was able to provide quicker, safer, and more efficient cleanup. Indeed, debris flow-related repair costs on SR-31 went from $600,000 in 2012 to just $80,000 in 2013 due to these road closures.[123] In addition, the state estimates that it saved $50,000 from reduced risk to field crews, motorists, and equipment on SR-31 alone.[124]

Utah also uploads the information it gathers from its RWIS and provides the public with real-time updated road conditions on its website and through a smartphone app.[125] Citizens are also encouraged to log into the app and report road conditions as they experience them. The app has been popular, with over 190,000 downloads at the end of the 2013 fiscal year in a state with only 3 million residents.[126] Citizen information is added to RWIS, allowing for increased accuracy and efficiency in RWIS weather reports and snow plow deployment.[127]

RWIS has led to a savings of $2.2 million in state snow and ice response activities and reduced car crashes in Utah by 39 percent.[128] These gains also benefited the community. Due to the government's increased mobility in making timely repairs, Utah reduced the time required for road closures, increasing traffic flow and contributing to reduced fuel costs, increased road safety, and decreased commute times.

Georgia's Kiosks Streamline Driver Services

Waiting in line for a driver's license can be frustrating. In 2012, new requirements from the U.S. Department of Homeland Security's Real ID Program—an enforcement plan that required secure driver's licenses and identification documents—made this process even worse in Georgia by significantly increasing wait times at customer service centers.[129] With the help of federal funding, Georgia's Department of Driver Services (DDS) set out to find a way to reduce these wait times.

Georgia employed a number of technical solutions. First, the state set up a pre-apply online program that enabled customers to complete a driver's license or identification card application over the Internet prior to visiting the customer service center. Within one year of implementation, more than 44,000 citizens had used the pre-apply program, reducing their wait times at DDS customer centers.[130] Georgia also made this service accessible via mobile, and as of the end of 2014, mobile users represented 38 percent of DDS's citizen driver's database.[131] When customers submit their applications via the online or mobile website, their stored information automatically pre-populates the customer's record, which reduces data entry errors and improves staff efficiency.

Second, DDS installed kiosks in its customer center lobbies that allowed customers to check in and print their own service number ticket. DDS kiosks function like a ticket dispenser with a touch-screen device that displays high-resolution graphics. The interface requires customers to navigate through only two screens before getting a service number and being assigned to a customer service representative, a process that typically takes less than two minutes to complete. Once signed in, customers are directed to a self-service area to complete the license application (if they have not already completed the pre-apply program online). There, customers can access and print missing documentation if they forgot it, thereby avoiding a second trip to the customer center.

These self-service tools cut the average wait time of customers at Georgia's centers by 39 minutes while also decreasing the time it took to complete a transaction from 20 minutes to 3. Given that DDS customer service centers in October 2014 processed 5,660 transactions, this efficiency is a time-savings of over 60,000 hours every year for both staff and customers at each of the four service centers where DDS initially rolled out the service.[132] DDS hopes to integrate this service into more of its 66 service centers over time. It also improved staff efficiency by cutting unnecessary tasks. For example, these service centers no longer need an employee to check in customers and distribute tickets.

The state also created 24-hour kiosks to allow for vehicle tag renewals. Because insurance and emissions tests are electronically submitted to the state, there is no physical paperwork required (except a driver's license and tag number) to renew a tag.[133] Citizens can renew up to 10 vehicles at once at a cost of $3 per vehicle. While these kiosks have only been rolled out in a few counties, further adoption will help improve efficiency and cut wait times at DDS customer centers. Georgia's switch to an online portal and self-service kiosks has increased DDS's data accuracy, reduced traffic at its customer centers, reduced fraud, and increased efficiency for both customer center staff and citizens alike.

Illinois Cuts Costs and Improves Taxpayer Compliance With an Online Portal

Before 2014, during tax season, the Illinois Department of Revenue (IDOR) faced a surging number of inbound emails and calls with citizen questions about state tax laws. The influx strained state call-processing centers. IDOR entered into a public-private partnership to implement an online portal powered to reduce this load and produce rapid responses to taxpayer questions. [134]

The new system, called the Taxpayer Answer Center, helped improve taxpayer compliance by creating a cross-channel solution that made taxpayer content consistent across the government's website, social media channels, and call centers. [135] The online portal automatically listed the top 20 most-asked questions for taxpayers, allowing a large percentage of website visitors to get their answer with one click. If the citizen's question was not within the top 20 most frequently asked questions, the online portal generated 500 question-and-answer pairs that allowed taxpayers viewing the system to quickly get the answers they wanted. By answering all of the common questions, the online portal was able to increase staff productivity by putting them to use answering more difficult questions that required expert knowledge.

Compared to private sector organizations, states have not been IT leaders due to budget limitations, bureaucratic restrictions, and limited incentives for change.

The system also generates reports for IDOR, flagging areas of the tax code that give customers particular trouble, such as a particular section with confusing language, allowing IDOR to quickly clarify language and reduce taxpayer error and time spent on corrections. This new system boosted citizen productivity by decreasing hold times and call processing times. In the end, this new system was able to reduce IDOR's email volume by 83 percent, and it purportedly payed for itself within six months. [136]

CHALLENGES IN USING IT TO RAISE GOVERNMENT PRODUCTIVITY

Despite the clear benefits to government, citizens, and businesses, public sector attempts to use IT to improve productivity have been sporadic at best when compared with a benchmark of full adoption and use. This benchmark assumes that every single function in every single state would have implemented IT in a cost-effective way in its government services—such as by replacing paper or face-to-face transactions—and adoption rates would be in the 90 to 100 percent range. While exact data on where states are vis-à-vis this benchmark are not available, it appears that they are a long way off. And this does not include keeping up to global best practice in emerging IT areas of data analytics, the Internet of things, kiosks, and mobile.

This is not to say that all private businesses have taken full advantage of the suite of IT tools available to them. Smaller companies generally are farther behind than larger ones. And some industries (such as information, financial services, and biotechnology) are generally farther ahead than others (such as hospitality and retail). [137] Moreover, OECD has shown the gap between the most productive firms and the rest is large and growing. [138] However, state governments are not small like small businesses, and much of what they do involves information processing functions. Therefore, there is no reason why they could not be leaders in productivity growth. In addition, states overall have not been IT leaders, especially compared with leading private sector organizations. In part this is due to budget limitations, bureaucratic restrictions, and more limited incentives for change.

There are four main reasons why state governments are generally behind the IT adoption and use curve compared with similar private sector organizations of their size: failure to adequately measure productivity benefits, IT budget and procurement constraints, organizational barriers, and resistance to downsizing

Failure to Adequately Measure Productivity

When state agencies make decisions about what IT programs they want to implement, they often do not weigh the productivity gains beyond their individual agency. Furthermore, when they report on the effectiveness of their projects, they rarely measure government productivity.

Most Governments Do Not Measure Productivity

Despite executing large programs to increase efficiency, most states have little idea of how their productivity has changed over time. Indeed, most governments—even the federal government—do not even track productivity gains.[139] The last time states and local governments had a solid measure of their productivity was in 1994 when the U.S. Congress cut funding to the Bureau of Labor Statistics' state and local government productivity series.[140] This means that most states do not know if their productivity is increasing or decreasing from year to year.

Defining Productivity Benefits Too Narrowly

For businesses, outputs are measured with a single endogenous quantity (i.e., firms maximize outputs for a given level of inputs). However, when it comes to the government's programs, the goal of any project is to maximize that program's overall value to the public. In this sense, productivity gains from IT-enabled government programs are not only by the government, but by the citizens, businesses, and local governments they serve as well.

All too often when agencies and appropriators make decisions about whether to fund IT programs, and evaluate already implemented programs for their effectiveness, they usually look only at impacts within the government enterprise and do not include broader economy-wide savings. Governments need to expand their measure of productivity to include nongovernmental gains. Doing so will increase the return on investment of many projects.

IT Budget and Procurement Constraints

When states make IT decisions, officials must often navigate complex budgetary and procurement processes. As states strive to be more agile and responsive, they face challenges that include IT systems that are out-of-date, inconsistent federal funding requirements, and a focus on performance metrics over cost savings.

Unwillingness to Invest to Modernize State Government IT Infrastructure

On average states spend 80 percent of their IT budget on maintaining existing systems, leaving only 20 percent of the budget for new IT investments.[141] And in some cases the legacy systems are inadequate, creating inefficiencies. For example, the Tennessee Comptroller's Office discovered that the state wrongly issued $98 million in unemployment claims, including checks to prisoners and the deceased over a six-year

period, because a 40-year-old malfunctioning computer system was filled with glitches, often forcing employees to revert to manual processes.[142] Maintaining inefficient and costly systems is expensive and limits the funds that states have to update these systems. Some state officials understand this barrier. "The biggest issue is money, given the billions of dollars needed to modernize those systems across the country," said Doug Robinson, executive director of National Association of State Chief Information Officers (NASCIO). "What many people don't understand is that the digital infrastructure is just as fragile as the physical infrastructure—the roads and bridges in need of repairs. Both require money to fix."[143] Many state systems are decades old, and are not interoperable, making sharing information and updating them even more costly.

Rather than invest more money now to upgrade systems so that maintenance costs are lower over time (and performance is higher), however, most states scrimp on capital expenditure investment but pay higher operational expenditures. In other words, too few state policymakers are willing to treat IT projects as long-term capital investments worthy of funding. Instead, they often fund IT on a year-to-year budget.[144]

From 2009 to 2013, the U.S. private sector increased investments in IT by 15 percent, or over $447 billion.[145] In contrast, state and local IT spending has remained fairly steady at around 3.6 percent of the total operational budget over the last five years, with state spending per employee actually declining to $8,355 in 2014 from $8,581 in 2013.[146] According to Deltek, states spent approximately $25.8 billion on IT in 2014.[147]

Federal Funding Often Creates Data Incompatibility Among State Agencies

Federal funds often support state IT. Unfortunately, this also leads to complications when federal requirements are inconsistent and ambiguous, and federal directives do not align with state priorities. For example, federal earmarks on state funding often restrict states from financing government software solutions because this investment is an intangible asset.[148] Similarly, online consumers of state websites cannot use a single login for multiple government websites because of inconsistent federal cybersecurity regulations for those agencies' funding.[149] This lack of federal coordination often further forces state IT programs into silos, especially when it comes to the data they collect. Different federal agencies may require different data standards, reporting requirements, programmatic rules, or IT infrastructure from other state agencies, leading to incompatibility among agencies within states.

Lack of federal alignment and coordination also hampers the possibility of future cross-boundary data sharing and shared services—a top priority for many states. For example, the Substance Abuse and Mental Health Services Administration (SAMHSA) awards block grants to state governments for substance abuse prevention and treatment, and community mental health services.[150] How states use this funding for treatment and prevention programs varies as do their reporting requirements. According to the SAMHSA website, grantees receive progress reporting guidelines and requirements at the time of the award.[151] Depending on the nature and goals of the specific program, reporting requirements for one state may not match the requirements of a neighboring state. This becomes a problem when sharing health information across state lines.

Organizational Barriers

Evidence from the private sector suggests that IT is most effective in driving productivity when it is associated with business process reengineering.[152] Both increased productivity and reengineering can disrupt governmental organizations and as such can run into obstacles from organizational cultures that typically resist change. Moreover, the state official in charge of executing IT efficiencies, usually the state Chief Information Officer (CIO), often lacks the authority to mandate IT-enabled reengineering, and in no state is there a chief productivity officer whose job it is to drive agency productivity. And even if agency heads decide to move forward with IT-enabled reengineering, agency employees can resist the change. The result is a lack of incentives for relevant stakeholders to change the status quo.

CIOs Lack Control

CIOs in most states lack control over the IT budgetary and procurement processes for individual agencies and only provide oversight to those agencies on a project-by-project basis.[153] Decentralized budget and procurement processes are not only complex and inconsistent, but they also limit the CIO's ability to understand the full scope of IT needs across the state.

One challenge starts with procurement. Nearly two-thirds of state-level CIOs view their procurement process as either somewhat or very ineffective.[154] Agency heads historically managed procurement processes independently to identify IT solutions that best matched their mission and goals. Therefore, agencies have their own stake in the procurement process and are hesitant to relinquish control to a centralized authority. While this disjointed process offers some benefits in the form of agency empowerment, it also leads to duplicative IT costs and muddled IT standards across the state. This dynamic also often forces CIOs to battle to change agency IT decisions and exercise their IT expertise in agencies' procurement decisions. This hinders the CIO's ability to provide interoperable IT solutions to state agencies while cutting duplicative efforts. If CIOs are unable to make purchasing decisions, then they are unable to choose IT investments that could boost the state's productivity.

State Agencies Do Not Sufficiently Leverage External Partnerships

State IT agencies often do not leverage third-party organizations as partners in providing e-government services and connecting government services to private ones.[155] Moreover, it is often difficult for agencies to be citizen-centric, designing applications with the needs of the user first and foremost in mind. Governments need to do more to think of themselves less as direct providers of e-government services and more as enablers of third-party integrators that tie together multiple agencies across multiple levels of government to package information, forms, regulations, and other government services and requirements in a user-friendly way.

State Agencies Lack Incentives to Cut Costs Through Productivity

There are three major goals of e-government: increase administrative efficiency, improve service, and increase citizen engagement.[156] Certainly all three are important. However, it is perhaps surprising that most governments focus more on the second goal—and to some

extent on the third—than they do on the first. Only a few states explicitly target headcount reduction through e-government or reward their employees or agencies for cutting costs and increasing their productivity. For example, Minnesota's Office of Continuous Improvement offers awards for productivity gains.[157] Moreover, without different incentives, many agencies are behaving rationally. Unlike the private sector that can keep its entire bottom-line savings, public sector agencies that cut costs and save money are usually rewarded with smaller budgets. If state employees believe that they will receive no reward or acknowledgement for improving the efficiency in their daily work, why would they bother to change anything?

As a result, government officials tend to make the case for increased government IT investment based on issues like employee retention, quality, and other often vague benefits, rather than how they can cut costs or generate the greatest value for the largest number of people. For example, it is often easier for state IT officials to argue for their budgets based on how IT can help agencies improve their performance rather than how it can help agencies employ a smaller workforce. Indeed, this adds to the perception that employee retention is always a positive, pushing policymakers not to commit to savings if achieving it requires downsizing the workforce.

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However, some foreign governments have been able to overcome this resistance and make it clear that a key goal of e-government is productivity. For example, the strategic plan developed by the Danish Agency for Digitisation makes it clear that the first of three goals of the strategy is "a productive and efficient public sector" and to get there they will focus on automation of public administrative procedures.[158] The U.K. government e-government strategy set a goal of 2.5 percent productivity improvements, including through headcount cuts.[159]

Resistance to Downsizing

Much of productivity improvement involves reduced headcount. For example, with self-service, users can access state services and complete transactions online without any face-to-face interaction. Reducing headcount can happen in one of three ways—attrition, redeployment, or downsizing the workforce. States often find it difficult to lay off government employees, forcing them to reduce their workforce through either attrition or redeployment. In fact, CIOs are often unwilling to discuss replacing state labor force with technology alternatives for fear that it will generate IT opposition.

This is in part because these new opportunities may be met with backlash as most state employees are unionized and public sector unions have placed a high emphasis on their members' job security. For example, in the case of the Massachusetts IT consolidation project in 2009, IT leadership had to consider union priorities of the National Association of Government Employees collective bargaining units before making any workforce changes.[160] Not only do staff and their respective collective bargaining units worry about potential layoffs, states must also overcome contract renegotiations that address seniority rights, department shifts, new responsibilities and job descriptions, and allowable participation in professional development and training activities.[161] In California, almost all state employees can engage in collective bargaining. This leads to situations where

negotiated labor contracts between California and state government employee unions allow state workers to retire, collect their pensions and then return to work, often making more money than they did before.[162] They also can purchase more lucrative pension benefits before they retire. This pushback often plays to the politics of headcount, where states do not want to be seen cutting any workers or reporting workforce reductions. Over 2 million state workers are represented by unions, which is a rate of 32.8 percent—almost five times higher than private-sector workers.[163] This institutional barrier to removing superfluous employees forces states to enter into hiring freezes as they wait for worker attrition.

RECOMMENDATIONS

States face many barriers to driving IT-enabled productivity. However, to make faster progress toward this goal, there are a number of steps that states should take.

Strategy Recommendations

If states are to better drive IT-enabled productivity, this goal needs to be elevated to a strategic level.

States Should Adopt Statewide IT-Enabled Productivity Strategies

States should develop IT-enabled productivity strategies with the explicit goal of being able to cut headcount while producing the same or higher level of services. This strategy should be led by the state CIO, and lessons learned should be shared among all state agencies and other states. This strategy would require a detailed analysis of each agency, evaluating how to reduce headcount and cut costs through IT-enabled systems. For example, if a CIO sees an opportunity to incorporate kiosks in public sector customer service centers, thereby reducing headcount and boosting efficiency, he or she should move to help the agency incorporate that technology. As part of these efforts, policymakers should not shy away from attrition or workforce reductions. Indeed, that is an indicator of success, as long as service quality and output are not cut.

In short, CIOs need to be more explicit about the promise of exchanging technology for labor. They need to articulate that a key purpose of state e-government should be to cut the costs of government, including labor costs. If state policymakers want to use those savings to expand services so that no workers are laid off, that can be their choice. Nevertheless, the CIO's role should be to drive IT-led productivity. This strategy should appeal to both sides of the political spectrum. Policymakers interested in decreasing the size of government can use the cost savings from this strategy to cut taxes. Policymakers interested in providing expanded public services can use cost savings to support additional services and investments.

Organizational Recommendations

CIOs serve an important role in state governments, creating a comprehensive IT vision for the state. However, governors should change this role to have their CIOs focus on improving productivity in all agencies and services through the use of IT. This change would require statewide CIOs to have increased decision-making authority.

Provide State CIOs With More Decision-Making Authority

In order for state CIOs to implement a comprehensive state productivity strategy, they will not only need increased authority, they will also need strong backing and leadership from the governor. Without the governor's leadership to overcome potential agency and legislative resistance, the most effective CIO will not succeed. CIOs cannot be the only voice for change in state government.

However, governors also need to elevate the role of the CIO, not just to provide the position with more authority to oversee a comprehensive IT strategy, but also a comprehensive IT-enabled productivity strategy. This strategy would enable CIOs to plan and coordinate IT investments with an eye to improving efficiency across all state operations, not merely focus on IT outcomes.

States should empower their state-level CIO (or the equivalent position) to oversee IT contracts, appropriate state funding for IT, make hiring and firing decisions, and optimize state data center usage. The goal of this governance structure would not be to undermine individual agency's missions or access to IT, but rather to give each state's IT efforts a singular vision and a flexible framework to increase the state's productivity. For example, Oklahoma's CIO is empowered through a flexible shared-services model to cross-train and move around the state's database administrators among agencies to fill gaps and meet agency's differing needs.[164]

State CIOs Should Be Productivity-Focused Rather Than Just IT-Focused

Much of what is fashionable for state CIOs is the promise of improving IT systems, such as switching from legacy systems to the cloud, acquiring better security suites, or developing comprehensive IT strategies. This approach is notable because more advanced systems do serve a purpose in cost cutting; however, this strategy is focused on overall IT improvement rather than using IT to solve individual problems. IT systems fundamentally promise to increase the efficiency and effectiveness in government through boosted productivity. To meet this need, CIOs should be focused not just on IT infrastructure, but also on IT-enabled process reengineering.

CIOs should proactively seek out technologies that can improve state processes, cut costs, and serve more citizens. CIOs should look for these opportunities, or encourage state agencies to look for these opportunities, in nontraditional places for IT (e.g., forestry, wildlife, or construction-focused agencies). For example, if a self-service mobile app can completely cut out the need for manual paper entry for a parks and recreation department, the CIO should investigate that opportunity.

States Should Set Dates by Which They Will No Longer Accept Non-Digital Interactions

While many state information functions dealing with businesses or citizens are digital, often the usage rate is low. This is usually because the state does not do enough to publicize the e-government channel. In many cases, the e-government channel is poorly designed, so that it is easier to use traditional paper forms. One step states could take would be for every e-government function to allow users to rank the ease of use of the transaction, with the

least user-friendly functions being highlighted every year to the public and the legislature. A second step would be to set deadlines for when users must interact digitally with the state. This is particularly important in business-to-government functions where virtually every business is online, or if it is not, it should be.

Budget Recommendations

When states budget for IT decisions, there are a number of changes they can make to improve their productivity, including tracking and rewarding internal productivity gains, accounting for external productivity gains, and embracing public-private partnerships to cut costs.

States Should Track and Reward Internal Productivity Gains

States should track and report their annual productivity gains, and productivity gains associated with each of their public projects. By assessing these gains from year to year, states can begin to understand if their IT investments are increasing overall productivity. This could be the function of the CIO or the state budget office. State policymakers should spur the state and its workforce's culture into one of continuous improvement and productivity, producing reports on the improvements, cost savings, and the overall productivity of the state of that year.

As part of this effort, states should establish programs that acknowledge and reward agencies and state employees for productivity gains. For example, in 2007 Minnesota created the Office of Continuous Improvement to find ways to reduce waste, save money, and make state services work better for Minnesotans. The office presents "Continuous Improvement Awards" to state employee teams for innovating and improving state services, with awards based on measurable improved outcomes; increased efficiencies such as time or cost savings; increased quality, compliance, or customer service; and high levels of employee involvement and engagement in the improvement efforts.[165] While IT use is not required to win the award, recipients often do just that. For example, in 2012, the Minnesota Department of Revenue won a 2012 Continuous Improvement Award for its e-Services system, which allowed businesses to pay taxes, file their returns, and access their information online.[166] This system not only saved businesses money, but also saved the state $400,000 a year.[167]

Similarly, a group called Florida TaxWatch issues annual "Prudential Productivity Awards" to state employees who reduced costs and improved services for Florida taxpayers.[168] For example, a team from the Florida Department of Highway Safety and Motor Vehicles was recognized for saving the state over $1.8 million as part of its database consolidation effort.[169]

States Should Account for External Productivity Gains in IT Budgeting

IT-enabled government applications should be evaluated not just on the basis of what they do for the government enterprise, but also on impacts on users' productivity. Therefore, even if an e-government application might not improve state productivity, it may cut costs for users. These benefits, such as reduced ti me for vehicle registration processing, less

waiting in lines at the state DMV, the ability to file government forms electronically, and others, should be considered when making decisions about investments.

Businesses are already seeing productivity growth through the use of government services. In one survey of Utah businesses, 91 percent said state e-government services saved them time; 86 percent said these services make it easier to conduct business in the state; and 85 percent said the services reinforce the notion that Utah is a business-friendly state.[170] When Utah implemented its RWIS system along SR31 to track flooding after a wild fire, it estimated that the state avoided $50,000 in costs to not only field crews, but Utah motorists as well.[171]

State policymakers often view investment in IT with a standard return on investment (ROI) ratio, which analyzes the amount of money a state invests and the internal return that the state realizes on that investment. When deciding to allocate budget authority for IT projects, states need to use an expanded definition of ROI to include nongovernmental entities such as businesses and citizens. Doing so will yield a larger ROI that will allow states to justify more IT investments as more projects exceed hurdle rates, the minimum positive effect that a state expects to realize when investing in a project. Therefore states should require all agencies to include productivity gains outside of government in their ROI calculations.

States Should Embrace E-Government Public-Private Partnerships

All too often state agencies are not able to get budget authority for investments, even those with a positive ROI. In these cases governments should consider engaging in partnerships. In some of these, business invests the capital to create and operate the program and keeps a share of the savings. These public-private partnerships are already creating savings in a myriad of different government programs. In these situations companies offer services to governments that are paid for through efficiency fees that usually range from $1 to $3 per transaction to cover the cost of building and maintaining IT-enabled government systems.[172] For example, when Montana automated many of its services, it used a self-funded model in which private firms supplied the service in exchange for a small fee added to online services that charge transaction fees.[173] Utah avoided $15 million in costs over five years when it moved nine of its services online through a self-funded model.[174] Because this model only pays the private interests when citizens or businesses use the government service, it acts as an incentive for the private sector to design user-friendly services and to actively market the service to users. This, in turn, brings more users to the service, increasing productivity for government and users.

In other types of partnerships, such as electronic state tax preparation, the private sector itself provides the service. There is no reason why more state services—particularly those related to business, such as the myriad of regulatory forms businesses must file—could not be set up so that external providers provide the service. This would require states to open up their systems to private sector integration. The advantage of such an approach is that private sector providers have a very strong incentive to increase the use and efficiency of the e-channel. Rather than making citizens come to government for services, this strategy will encourage government services to go to people. For example, there is no reason why car

registration cannot be integrated into existing online transactions that are engaged when and where a car is purchased or insured. Indeed, citizens should be able to aggregate a wide share of federal, state, and local government recurring transactions, such as passport renewal, driver's license applications, and car emissions tests, and be able to have third-party private sector providers be the middleman for them in engaging with government electronically.

Furthermore, these IT public-private partnerships may grow in importance as states find it more difficult to attract qualified IT workers. Indeed, states also report difficulties recruiting and retaining qualified IT personnel.[175] In fact, 86 percent of states support this claim, saying they encounter difficulties filling vacant positions.[176] Nearly 92 percent of states believe salary rates and pay grade structures present a challenge for attracting needed IT staff.[177] States can start to address this issue by engaging in public-private partnerships for IT services that supplant the need for workers.

Intergovernmental Recommendations

State governments, should establish internal "venture" funds to support innovative internal programs.

Government collaboration and asset sharing are invaluable to producing productivity benefits across the public sector. The following section offers recommendations for governments to work together to boost public sector productivity.

OMB Should Establish a Process to Harmonize Federal Agency Grant Requirements Related to IT

As detailed above, federal funding directives often allow different data standards, reporting requirements, programmatic rules, or IT infrastructure among state agencies. Indeed, program requirements and directives imposed by federal agencies have unintentionally hindered state government efforts to integrate program delivery, update service channels, and lower costs. Recognizing this problem, the White House issued a memorandum in 2011 entitled "Administrative Flexibility, Lower Costs, and Better Results for State, Local, and Tribal Governments," which directed states to simplify and harmonize overlapping requirements.[178] However, many differing standards remain today. The Office of Management and Budget should incorporate language into its funding that allows states to develop certain IT and software standards, so they can use similar standards among agencies, local governments, and other states. The federal government could set minimum guidelines for certain areas such as security, but offer states the flexibility to implement those guidelines.

Both Federal and State Governments Should Create Incentive Programs for IT-Led Productivity

Some businesses have established internal "venture" funds to support innovative internal programs, including ones that boost productivity. State governments should do the same. State agencies should be able to apply for relatively modest grants to beta test new approaches that hold promise for driving productivity improvements. If the pilot is successful and shows promise, the agency can include expanded funding in its overall budget request or seek to partner with the private sector on an e-government public-private partnership.

However, the federal government needs to also play a role. One challenge is that some of the benefits of state IT programs spill over to other states. Another challenge is that the IT solutions developed in one state could be relatively easily replicated in other states, but for a variety of reasons are not. The U.S. federal government should adopt a productivity interstate services challenge program to address these issues, operated out of the federal CIO office.

States Should Cooperate on Shared IT Services

One interesting, but little noticed economic trend over the last decade is how IT has allowed for an increase in average firm size in the United States. IT enables firms to gain scale. For example, insurance companies do not need 50 different customer service or claims processing centers. They can use IT to consolidate their service centers. If states were businesses, by now they would have consolidated into a smaller number than 50 in order to gain scale economies enabled by IT, both in the development of IT applications and in the operations of IT-enabled services. But clearly they are not businesses and do not have that freedom. But that does not mean that states could not enter into partnerships with other states to share not only e-government applications but actual operations. Most states officials will respond that their state is unique and under no circumstances would be able to share operations with another state. At one level that is right, as each state is unique. But for many operations characterized by routine functions (e.g., renewing driver's licenses), there is much that states have in common, and the beauty of IT is that it can relatively easily incorporate customization.

Toward that end, groups like the National Association of State Chief Information Officers (NASCIO) should work to establish an IT platform-sharing system, which multiple states would contribute to and benefit from. Each state would benefit from the collective action of its peers, and state IT software suites—a collection of computer programs that share a common user interface—bought by the states can be of a better quality than any single state can purchase with its own budget. In addition, individual states, especially small ones, should experiment with small-scale shared-service efforts, perhaps just with a neighboring state, to develop shared systems.

CONCLUSION

IT is powering productivity in virtually every sector of the economy. Yet states do not appear to have taken full advantage of emergent IT systems to drive government productivity. Now is the time to fulfill the original promise of e-government: not only to provide better and more convenient services, but to drive productivity in state government and state economies.

ENDNOTES

1. Information Technology and Innovation Foundation (ITIF) estimate based on the U.S. Department of Labor Bureau of Labor Statistics data on state government workers, excluding schools and hospitals in 2014.
2. Robert D. Atkinson, "Competitiveness, Innovation and Productivity: Clearing up the Confusion" (Information Technology and Innovation Foundation, August 2013), http://www2.itif.org/2013-competitiveness-innovation-productivity-clearing-up-confusion.pdf.
3. Robert D. Atkinson et al., "Taking on the Three Deficits" (Information Technology and Innovation Foundation, November 2011), http://www.itif.org/publications/taking-three-deficits-0.
4. Marcella Corsi and Carlo D'ippoliti, "The Productivity of the Public Sector: A Classical View," *PSL Quarterly Review* 66, no. 267 (2013): 403–434, http://ojs.uniroma1.it/index.php/PSLQuarterlyReview/article/view/11547/11417.
5. Elizabeth McNichol, "Some Basic Facts on State and Local Government Workers," (Center on Budget and Policy Priorities, June 15, 2012), http://www.cbpp.org/research/some-basic-facts-on-state-and-local-government-workers?fa=view&id=3410.
6. Lucy Dadayan and Donald Boyd, "The Depth and Length of Cuts in State-Local Government Employment Is Unprecedented" (Nelson A Rockefeller Institute of Government, January 2013), http://www.rockinst.org/pdf/government_finance/2013-01-09-State-Local_Government_Employment.pdf.
7. Bureau of Labor Statistics, State Government Employees by Function 2013 (accessed September 22, 2015), http://data.bls.gov/. This chart is based on data from the Bureau of Labor Statistics and depicts state government full time equivalents by function excluding education, health, and hospitals from 1992 to 2013.
8. Bureau of Labor Statistics, State Government Occupational Employment and Wage Estimates 2014 (accessed September 22, 2015), http://data.bls.gov/. This chart is based on data from the Bureau of Labor Statistics on state government full time equivalents by occupation excluding schools and hospitals in May 2014.
9. Ibid.
10. Jerry Mechling, "Technology's Real Value for Government," *Government Technology*, January 9, 2013, http://www.govtech.com/pcio/articles/Technologys-Real-Value-for-Government.html. We chose the 2.5 percent benchmark for our estimation based on Jerry Mechling's estimates.
11. Bureau of Labor Statistics, Major Sector Multifactor Productivity (Private Non-Farm Business Sector, Labor Productivity, 2000–2014; accessed September 22, 2015); http://data.bls.gov/.
12. For labor cost data see Bureau of Labor Statistics, State Government Occupational Employment and Wage Estimates 2014. Employment data is based on state government full time equivalents by occupation, excluding schools and hospitals.
13. Bureau of Labor Statistics, Estimates 2014. Estimates based on Bureau of Labor Statistics state occupational data and ITIF's likely annual productivity growth factors due to ease of automation, compounded over 5 years.
14. Zhiyuan Fang, "E-Government in Digital Era: Concept, Practice, and Development," *International Journal of the Computer,* The Internet and Management10, no. 2 (2002): 1–22.
15. Cabinet Office, "Government Digital Strategy," (United Kingdom, last modified December 10, 2013, https://www.gov.uk/government/publications/government-digital-strategy.
16. Tony Danker et al., "How Can American Government Meet Its Productivity Challenge," *McKinsey Global Institute*, July 2006, 7, http://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/public%20sector/pdfs/how_can_american_government_meet_its_productivity_challenge.ashx.
17. John King and Kenneth Kraemer, "Information Technology and Administrative Reform: Different?" *International Journal of Electronic Government Research*, August 2003, 1–20.
18. William Lehr and Frank Lichtenberg, "Computer Use and Productivity Growth in Federal Government Agencies, 1987 to 1992," (working paper, *National Bureau of Economic Research*, June 1996).
19. Geunjoo Lee and James Perry, "Are Computers Boosting Productivity? A Test of the Paradox in State Governments," *Journal of Public Administration Research and Theory*, January 2002.

20. Min-Seok Pang, Ali Tafti, and M.S. Krishnan, "Information Technology and Administrative Efficiency in U.S. State Governments—A Stochastic Frontier Approach," *Information Technology and Administrative Efficiency in U.S. State Governments*, May 19, 2011, https://www.maxwell.syr.edu/uploadedFiles/conferences/pmrc/Files/Pang_Information%20Technology%20and%20Administrative%20Efficiency%20in%20U.S.%20State%20Governments%20-%20A%20Stochastic%20Frontier%20Approach.pdf.
21. Min-Seok Pang, Ali Tafti, and M.S. Krishnan, "Do CIO IT Budgets Explain Bigger or Smaller Governments? Theory and Evidence From U.S. State Governments," *Management Science*, July 21, 2015, http://dx.doi.org/10.1287/mnsc.2015.2164.
22. Corsi and D'ippoliti, "Productivity of Public Sector," 403–434.
23. Ibid.
24. Mink-Seok Pang, "Do Information Technology Investments Lead to Bigger or Smaller Governments?–Theory and Evidence in U.S. State Governments," *International Conference on Information Systems (ICIS)*, 2010, http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1055&context=icis2010_submissions.
25. Jae Moon and Donald Norris, "Does Managerial Orientation Matter? The Adoption of Reinventing Government and E-Government at the Municipal Level," *Information Systems Journal 15*, no. 1 (2005): 43–60; Paolo Seri and Antonello Zanfei, "The Coevolution of ICT, Skills and Organization in Public Administrations: Evidence from European country-level data," 1st International EIBUS-TAIPS TAIPS conference, April 19 2012; Younhee Kim, "Improving Performance in U.S. State Governments," *Public Performance and Management Review*, 34 no.1 (2010): 104–29. Not about tech specifically.
26. Luis Garicano and Paul Heaton, "Information Technology, Organization, and Productivity in the Public Sector: Evidence from Police Departments," *Journal of Labor Economics* 28, no. 1, 167–201.
27. Timothy F. Bresnahan, Erik Brynjolfsson, and Lorin M. Hitt, "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence," *Quarterly Journal of Economics* 117, no. 1 (February 2002): 339–76, doi:10.1162/003355302753399526; Nicholas Bloom, Raffaella Sadun, and John Van Reenen, "Americans Do IT Better: US Multinationals and the Productivity Miracle," *American Economic Review* 102, no. 1 (February 2012): 167–201, doi:10.1257/aer.102.1.167.
28. Mary Brown, "Revisiting the IT Productivity Paradox," *American Review of Public Administration*, (April 30, 2014): 1–19, http://arp.sagepub.com/content/early/2014/03/03/0275074014523102.
29. Geunjoo Lee and James Perry, "Are Computers Boosting Productivity? A Test of the Paradox in State Governments," *Journal of Public Administration Research and Theory* 12, no. 1 (2002): 77–102.
30. Mink-Seok Pang, "Information Technology Investments Governments?"
31. Kwi-Hee Bae and Keon-Hyung Lee, "Internet, Municipal Governance, and Local Economic Development: A Case of the Los Angeles Basin Area," *International Review of Public Administration* 12, no. 2 (2008).
32. Donald Norris and Christopher Reddick, "Local E-Government in the United States: Transformation or Incremental Change?" *Public Administration Review* 73, no. 1 (2013): 165–175.
33. Ibid.
34. Lourdes Torres et al., "E-Government and the Transformation of Public Administrations in EU Countries: Beyond NPM or just a second wave of reforms?" *Documento de Trabajo, Universidad de Zaragoza*, 2005.
35. "Virtualized Program Reforms California Correctional Health System," Cisco, 2012, http://www.cisco.com/c/dam/en/us/products/collateral/collaboration-endpoints/collaboration-room-endpoints/california_correctionalhealthcareservices.pdf.
36. National Association of State Chief Information Officers (NASCIO), "Michigan's HR Optimization Project—NASCIO Case Study," (Michigan, 2006), https://www.michigan.gov/documents/dmb/Michigans_Human_Resource_HR_Optimization_Project_325958_7.pdf.
37. Arkansas State Technology Council, "State of Arkansas Strategic Plan for Information Technology" (November 2012), http://stc.arkansas.gov/Documents/State_Strategic_%20Plan_%202013-2015.pdf.
38. NASCIO, "Unemployment Insurance (UI) Tax & Claims System," (New Mexico, January 2013), http://www.nascio.org/portals/0/awards/nominations2014/2014/2014NM4-NASCIO%202014%20Award%20Application.pdf.

39. NASCIO, "Preventing Healthcare Fraud Through Predictive Modeling," (Massachusetts, July 2013), http://www.nascio.org/portals/0/awards/nominations2015/2015/2015MA6-Massachusetts_MassHealth_Improving%20State%20Operations_6.1.2015.pdf.
40. NASCIO, "TxSmartBuy System Upgrade to Cloud-based eCommerce Technology," (Texas, October 31, 2014), http://www.nascio.org/portals/0/awards/nominations2015/2015/2015TX5-2015%20Texas%20CPA%20TSB2%20Award%20Submission.pdf.
41. NASCIO, "OntheGo (OtG)–Mobile Payments," (Idaho, December 1, 2013), http://ita.idaho.gov/awards/2014/2014NASCIO_AwardEntry_OtG.pdf.
42. Michigan, "Michigan's HR Optimization Project."
43. NASCIO, "Vehicle Registration Renewal iPad Kiosks Dramatically Reduce Wait Time at Arkansas Revenue Offices," (Arkansas, July 2014), http://www.nascio.org/portals/0/awards/nominations2015/2015/2015AR3-NASCIOAwardSubmission2015-ARStarKiosks11-1.pdf.
44. University of Utah Center for Public Policy and Administration, "Smarter eGovernment: The Benefits of Online Services for Utah Businesses," (2013), http://media.navigatored.com/documents/UofU+business+survey+results.pdf.
45. NASCIO, "Corporation Filings Automation Saves Arkansas Secretary of State $124,212," (Arkansas, June 2013), http://www.nascio.org/portals/0/awards/nominations2015/2015/2015AR6-NASCIOAwardSubmission2015-AutoDrop1.pdf.
46. "SOMS Project Earns National Award," California Department of Corrections and Rehabilitation, accessed September 29, 2015, http://www.cdcr.ca.gov/SOMS/index.html.
47. California Department of Corrections and Rehabilitation, "Enterprise Information Services – Strategic Offender Management System Project," (NASCIO, December 2014), http://www.nascio.org/portals/0/awards/nominations2015/2015/2015CA6-NASCIO%20CDCR%20SOMS%202015.pdf.
48. Colorado Governor's Office of Information Technology, "Mobile Friendly Case Management Solution for Colorado Adult Protective Services," (NASCIO, July 1, 2014), http://www.nascio.org/portals/0/awards/nominations2015/2015/2015CO6-Mobile%20Friendly%20Case%20Management%20Solution%20for%20Colorado%20Adult%20Protective%20Services.pdf.
49. Utah Department of Transportation (UDOT), "2013 Annual Efficiencies Report," (March 2014), http://www.udot.utah.gov/main/uconowner.gf?n=14393526959106954.
50. Michael Goldberg, "Analytics Paves the Way for Better Government," *Forbes*, September 2014, http://www.sap.com/bin/sapcom/en_us/downloadasset.2014-09-sep-05-12.analytics-paves-the-way-for-better-government-pdf.bypassReg.html.
51. Ibid.
52. Jessica Hughes, "Indiana Management and Performance Hub Takes Transparency to the Next Level," *Government Technology*, September 11, 2014, http://www.govtech.com/data/Indiana-Management-and-Performance-Hub-Takes-Transparency-to-the-Next-Level.html.
53. Tony Cook, "Gov. Pence Spends $338,000 on Data Hub in Statehouse," *Indianapolis Star*, September 10, 2014, http://www.indystar.com/story/news/politics/2014/09/09/gov-pence-spends-data-hub-statehouse/15357277/.
54. "Golden Gov: State Executive of the Year," StateScoop, accessed September 23, 2015, http://statescoop.com/statescoop50/2015/vote/.
55. "Indy Corporate Hack," *Techpoint*, accessed November 23, 2015, http://techpoint.org/indy-civic-hack/.
56. Mohana Ravindranath, "In Indiana, State Government Tries Using Big Data Project to Reduce Infant Mortality," *Washington Post*, August 24, 2014, http://www.washingtonpost.com/business/on-it/in-indiana-state-government-tries-using-big-data-project-to-reduce-infant-mortality/2014/08/23/66d57bc0-2973-11e4-8593-da634b334390_story.html.
57. NASCIO, "Labor of Love: Indiana Infant Mortality Study," (Indiana, 2015), http://www.nascio.org/portals/0/awards/nominations2015/2015/2015IN8-2015%20NASCIO%20Infant%20Mortality%20-%20Data,%20Information%20and%20Knowledge%20Management.pdf.

58. "Reducing Infant Mortality in Indiana," (Indiana Management Performance Hub, December 2014), http://media.navigatored.com/documents/Indiana+Infant+Mortality+Advanced++Data+Analytics+Report.pdf.
59. NASCIO, "Labor of Love."
60. Ibid.
61. Ibid.
62. NASCIO, "Mobile Highway Construction App, Improving State Operations," (Pennsylvania, 2015), http://www.nascio.org/portals/0/awards/nominations2015/2015/2015PA6-PennDOT%20Mobile%20Highway%20Construction%20App%20Improving%20State%20Operations%20NASCIO%202015%20FINAL.pdf.
63. Pennsylvania, "Posted and Bonded Roads Mobile App," (NASCIO, 2014), http://www.nascio.org/portals/0/awards/nominations2014/2014/2014PA7-2014%20NASCIO%20write-up%20%20Posted%20and%20Bonded%20Road%20Mobile%20App%20FINAL.pdf.
64. Ibid.
65. Ibid.
66. Ibid.
67. NASCIO, "Mobile Highway Construction App."
68. Prior to the introduction of this app, administrative tasks consumed roughly 25 percent of an inspector's day. See, Ibid.
69. Ibid.
70. Ibid.
71. Ibid.
72. Ibid.
73. Bureau of Business and Economic Research, University of Montana, "Montana's eGovernment Services: Assessing the Last Decade," January 2015, http://www.bber.umt.edu/pubs/econ/MTeGovernment.pdf.
74. Ibid. This estimate includes costs of the program.
75. Ibid.
76. NASCIO, "Discovering Montana's Business Entity Annual Report Service," (Montana, 2005), http://new.nascio.org/portals/0/awards/nominations2005/2005/2005Montana1.pdf.
77. Ibid.
78. U.S. Census Bureau, "Montana," accessed May 28, 2015, http://quickfacts.census.gov/qfd/states/30000.html. The U.S. Census estimates that in 2007 the number of firms in Montana was over 114,000. Given even a 50 percent adoption rate that year, firms would have been saved over $285,000.
79. Bureau of Business and Economic Research, "Montana's eGovernment Services."
80. Montana Department of Corrections, "2015 Biennial Report on Information Technology," January 2, 2015, http://cor.mt.gov/Portals/104/Resources/Reports/2015BiennialReport.pdf.
81. Bureau of Business and Economic Research, "Montana's eGovernment Services."
82. Montana Department of Corrections, "2015 Biennial Report."
83. Ibid.
84. Ibid.
85. Ibid.
86. Ibid.
87. Ibid.
88. Ibid.
89. Ibid.
90. Virginia Department of General Services, "Virginia's Enterprise Electronic Procurement System: Benefits and Savings," August 2014, https://eva.virginia.gov/cd/files/evafact1benefits-savings.pdf.
91. Ibid.
92. Ibid.
93. Ibid.
94. Ibid.

95. Virginia Department of General Services, "eVA Mobile Apps," (National Association of State Procurement Officials, accessed September 23, 2015), http://www.naspo.org/dnn/portals/16/documents/2014Cronin_Award_NominationVirginia.pdf.
96. Ohio Office of Information Technology, "Consolidated IT Transformation Approach," (December 2013), http://das.ohio.gov/Portals/0/DASDivisions/InformationTechnology/pdf/Consolidated%20IT%20Transformation%20Approach%20FINAL.pdf.
97. NASCIO, "Health and Human Services Transformation through Ohio Benefits System Implementation," (Ohio, 2015), http://www.nascio.org/portals/0/awards/nominations2015/2015/2015OH1-NASCIO%20Awards_Ohio%20Benefits_%20FINAL.pdf.
98. Ohio, "Ohio Integrated Eligibility Project" (accessed September 23, 2015), http://www.healthtransformation.ohio.gov/LinkClick.aspx?fileticket=sAgBQ83GIF4%3d&tabid=117; Ohio Office of Information Technology, "Consolidated IT Transformation Approach;" The contract value for Deloitte is worth $18.8 million over three fiscal years. The state is eligible for a 90 percent federal match for the project.
99. Ibid.
100. NASCIO, "State of Ohio: Integrated Eligibility System," (Ohio, accessed September 23, 2015), http://www.nascio.org/portals/0/awards/nominations2014/2014/2014OH1-NASCIO%20State%20IT%20Award-Ohio%20Integrated%20Eligibility%20FINAL1.pdf.
101. Ohio Office of Information Technology, "Consolidated IT Transformation Approach."
102. NASCIO, "Integrated Eligibility System."
103. Ibid.
104. Ibid.
105. NASCIO, "Health and Human Services Transformation."
106. Ibid.
107. Mark M. Meinero and Ben Rooney, "Gas Price Record Reaches $4 a Gallon," *CNN Money*, June 8, 2008, http://money.cnn.com/2008/06/08/news/economy/gas_prices/; Barbara Johnston and Neil A. Solomon, "Telemedicine in California: Progress, Challenges, and Opportunities," NAS Consulting Services, July 2008, http://www.chcf.org/~/media/MEDIA%20LIBRARY%20Files/PDF/PDF%20T/PDF%20TelemedicineInCA.pdf.
108. Johnston and Solomon, "Telemedicine in California."
109. "Virtualized Program Reforms California," Cisco.
110. "Public Safety, Justice, and the Internet of Everything," Cisco, 2014, http://www.nascio.org/events/sponsors/vrc/Public%20Safety%20Justice%20and%20the%20Internet%20of%20Everything.pdf.
111. "Virtualized Program Reforms California," Cisco.
112. Ibid.
113. Johnston and Solomon, "Telemedicine in California: Progress, Challenges, and Opportunities." This number is based on FY04-05 numbers before the state aggressively expanded the program.
114. Oregon Department of Transportation (ODOT), "OR217 Active Traffic Management (ATM) Project," (NASCIO, October 31, 2014), http://www.nascio.org/portals/0/awards/nominations2015/2015/2015OR6-Oregon-ODOT-2015%20-%20OR217%20ATM%20Project.pdf.
115. "OR 217 ATM Project, OR," DKS Associates, accessed September 23, 2015, http://www.dksassociates.com/projects/or-217-active-traffic-management/.
116. ODOT, "OR217 ATM Project."
117. This estimate is based on the average number of drivers on Route 217 each day, the average time-savings for each trip, and Oregon's minimum wage.
118. ODOT, "OR217 ATM Project"; Dennis Mitchell, "Variable Speed Limits," (Oregon Department of Transportation, September 2013), http://www.oregon.gov/ODOT/HWY/TRAFFICROADWAY/docs/pdf/2013_conference/Session_3C_Mitchell.pdf.

119. Utah Department of Transportation, "2014 Annual Efficiencies Report," November 2014, http://www.udot.utah.gov/main/uconowner.gf?n=19046126944591427.
120. Hilton Collins, "Utah Network of Cameras and Sensors Keeps Traffic Moving," *Government Technology*, February 6, 2014, http://www.govtech.com/transportation/Utah-Network-of-Cameras-and-Sensors-Keeps-Traffic-Moving.html.
121. UDOT, "2014 Annual Efficiencies Report," November 2014, http://www.udot.utah.gov/main/uconowner.gf?n=19046126944591427.
122. UDOT, "2013 Annual Efficiencies Report."
123. Ibid.
124. Ibid.
125. "Current Road Conditions," *UDOT Traffic, accessed* September 23, 2015, http://udottraffic.utah.gov/RoadWeatherForecast.aspx.
126. Utah State Legislature, "Performance," accessed September 23, 2015, http://www.le.utah.gov/lfa/reports/cobi2015/Agcy_810.htm#performanceTab.
127. Brad Sowell, "NASCIO 2014: States Adopt Smart Sensors," *StateTech*, October 3, 2014, http://www.statetechmagazine.com/article/2014/10/nascio-2014-states-adopt-smart-sensors.
128. Ibid.
129. Georgia Department of Driver Services, "Georgia Department of Driver Services Turns to IT to Accelerate Customer Service" (NASCIO, October 2014), http://www.nascio.org/portals/0/awards/nominations2015/2015/2015GA6-NASCIO%20submission,%20Georgia%20Department%20of%20Driver%20Services.pdf.
130. Ibid.
131. Ibid.
132. Ibid. This estimate was calculated using the average savings for wait time and transaction time reduction.
133. Georgia Department of Revenue, "MVD Self-Service Centers," accessed September 23, 2015, http://dor.georgia.gov/mvd-self-service-centers.
134. "Illinois Department of Revenue Uses Multichannel Contact Center to Improve Service, Cost-Efficiency, and Taxpayer Compliance," Oracle, accessed October 5, 2015, http://www.oracle.com/us/corporate/customers/customersearch/illinois-dept-1-service-cloud-ss-2355093.html.
135. Illinois Department of Revenue (IDOR), "Got Questions? Get Answers," accessed October 5, 2015, http://www.revenue.state.il.us/AboutIdor/QandA.htm.
136. "IDOR Multichannel Contact Center," *Oracle.*
137. "2015 InformationWeek Elite 100 Winners." *InformationWeek*, 2015, http://www.informationweek.com/2015-informationweek-elite-100-winners/d/d-id/1319767. For rankings on sectors see InformationWeek, searching by industry.
138. Organisation for Economic Co-Operation and Development (OECD), "The Future of Productivity," 2015, http://www.oecd.org/eco/growth/OECD-2015-The-future-of-productivity-book.pdf.
139. Congress has cut funding to two series: 1996 federal government productivity series. It still collects information on the postal service.
140. Danker et al., "American Government Productivity Challenge."
141. Infosys Public Services and NASCIO "Is State IT Working on the Right Things?" 2015, http://www.nascio.org/publications/documents/NASCIO_InfoSys-Is_State_IT_Working_on_the_Right_Things.pdf.
142. Anita Wadhwani, "'Technological Limitations' Take Costly Toll on TN Government," *The Tennessean*, May 31, 2015, http://www.tennessean.com/story/news/politics/2015/05/31/tennessee-computer-failures-cost-millions-hurt-real-people/28173507/.
143. Ibid.
144. For example, see North Carolina General Assembly, "Information Technology 2014–2015 Fiscal Year Budget Highlights," (State Library of North Carolina, October 9, 2014), http://cdm16062.contentdm.oclc.org/cdm/ref/collection/p16062coll9/id/160526; NASCIO, "Innovative Funding For State IT" (September 2008), http://www.nascio.org/publications/documents/NASCIO-InnovativeFunding2008.pdf.

145. "Database of Information and Communication Technology (ICT) Investment and Capital stock Trends: Canada vs United States, ICT in US, 1987–2013, Table 18," Centre for the Study of Living Standards, updated January 30, 2015, http://www.csls.ca/data/ict.asp. It is important to note that although IT investment in absolute numbers has gone up, as a proportion of GDP and Total Business Investments, it has gone down relatively.
146. Linda Hall, Shreya Futela, and Disha Gupta, "IT Key Metrics Data 2015: Key Industry Measures: Government–National and International Analysis: Multiyear," *Gartner*, December 15, 2014.
147. Chris Cotner, "State IT Budget Analysis and Forecast for 2015: Changes and opportunities on the horizon," *Deltek*, 2015.
148. NASCIO, "Innovative Funding For State IT."
149. Camilla Nawaz, "State Technology: A case for less rules, and more collaboration," *GovLoop*, February 2, 2015, https://www.govloop.com/state-technology-case-less-rules-collaboration/.
150. Substance Abuse and Mental Health Services Administration (SAMHSA), "Substance Abuse and Mental Health Block Grants" (Rockville, MD: SAMHSA , July 6, 2015), http://www.samhsa.gov/grants/block-grants.
151. SAMHSA, "Post-Award Reporting Requirements" (Rockville, MD: SAMHSA , December 10, 2014), http://www.samhsa.gov/grants/grants-management/reporting-requirements.
152. Erik Brynjolfsson and Andrew McAfee, *The Second Machine Age* (New York City, NY: W.W. Norton & Company, January 13, 2014).
153. NASCIO, "State CIO Leadership in Government Innovation and Transformation," October 2013, http://www.nascio.org/publications/documents/State-CIO-Leadership-Final.pdf.
154. NASCIO, "The Enterprise Imperative: Leading Through Governance, Portfolio Management, and Collaboration," *The 2013 State CIO* Survey, October 2013, http://www.nascio.org/publications/documents/2013_State_CIO_Survey_FINAL.pdf.
155. Robert D. Atkinson, "'Turbo Government': A Bold New Vision for E-Government," (Information Technology and Innovation Foundation, September 27, 2006), http://www.itif.org/publications/2006/06/01/turbo-charging-e-government.
156. Jeremy Rose, John Persson, Lise Heeager, "How E-Government Managers Prioritize Rival Value Positions: The efficiency imperative," *Aalborg Universitet*, 2015, http://vbn.aau.dk/files/218247275/Rose_et_al_2015_How_e_Government_managers_prioritise_rival_value_positions_the_efficiency_imperative.pdf.
157. Minnesota Office of Continuous Improvement, "Governor's Continuous Improvement Awards" (accessed September 23, 2015), http://mn.gov/admin/lean/results/governors-awards/.
158. "Denmark Working on New Joint Government eGovernment Strategy," *News UK*, November 26, 2014, http://www.digst.dk/Servicemenu/English/News/Denmark-working-on-new-joint-government-eGovernment-Strategy.
159. "e-Government in the UK," e-*service expert*, accessed September 23, 2015, http://www.e-service-expert.com/e-Government-UK.html.
160. Anthony Foy, "Secretariat IT Consolidation Phase 1 Meetings and Presentations," *Secretariat IT Consolidation Initiative,* June 8, 2009, https://wiki.state.ma.us/confluence/display/itconsolidation/Secretariat+IT+Consolidation+Phase+1+Meetings+and+Presentations.
161. Commonwealth of Massachusetts, "Organizational Development Plan" (June 18, 2009), https://wiki.state.ma.us/confluence/download/attachments/37552640/IT+Consolidation+Organizational+Development+Plan+June+18+2009.v12.pdf.
162. Emily Wagster Pettus and Erik Schelzig, "Union Bargaining a Dream for Many State Workers," *NBC*, 2011, http://www.nbcnews.com/id/41810901/ns/business-us_business/t/union-bargaining-dream-many-state-workers/#.VgCKPhHBzRY.
163. Bureau of Labor Statistics U.S. Department of Labor, "Union Members—2014," news release, January 23, 2015, http://www.bls.gov/news.release/pdf/union2.pdf.
164. Interview with James "Bo" Reese, Chief Information Officer of the State of Oklahoma, July 23, 2015.
165. Minnesota Office of Continuous Improvement, "Nominations Now Open for 2014 Continuous Improvement Awards" (September 2014), http://mn.gov/admin/images/ci_newsletter_september2014.pdf .

166. Minnesota Revenue, "e-Services System Receives 2012 Governor's Continuous Improvement Award," news release, December 7, 2012, http://www.revenue.state.mn.us/newsroom/Documents/20121207%20eServices%20award%20release.pdf.
167. Ibid.
168. "Prudent Productivity Rewards," *Florida TaxWatch*, accessed September 25, 2015, http://www.floridataxwatch.org/Events/PrudentialProductivityAwards.aspx.
169. Karl Etters, "Productivity Awards Mark State Employee Innovation," *Tallahassee Democrat*, March 12, 2015, http://www.tallahassee.com/story/news/2015/03/12/productivity-awards-mark-state-employee-innovation/70221012/.
170. University of Utah Center for Public Policy and Administration, "Smarter eGovernment."
171. UDOT, "2013 Annual Efficiencies Report."
172. "Delivering eGovernment efficiencies daily," *NIC*, accessed September 23, 2015, http://www.egov.com/what-we-do.
173. Ibid.
174. University of Utah Center for Public Policy and Administration, "Smarter eGovernment."
175. Center for State and Local Government Excellence, "State and Local Government Workforce: 2014 trends," May 2014, http://slge.org/wp-content/uploads/2014/05/Workforce_Trends_2014.pdf.
176. NASCIO, "State IT Workforce: Facing Reality with Innovation,"2015, http://www.nascio.org/publications/documents/NASCIO_StateITWorkforceSurvey2015_WEB.pdf.
177. Ibid.
178. President Barack Obama to the Heads of Executive Departments and Agencies, February 28, 2011, "The White House Office of the Press Secretary, memorandum on administrative flexibility, lower costs, and better results for state, local, and tribal governments," https://www.whitehouse.gov/sites/default/files/2011_Flexibility_Memo.pdf.

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