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EDITORIAL

The Transformation of Government Accountability and Reporting

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ABSTRACT: This paper advocates for a drastic transformation of government accountability and reporting. With the availability of Big Data and the advancement of technologies, the existing government reporting schema fails to meet the public's increasing demand for accountability. We discuss the need for the government to reform its reporting schema and prescribe potential paths toward a data-driven, analytics-based, real-time, and proactive reporting paradigm. We conceptualize an app-based continuous monitoring and reporting environment that is real-time, structured, future-oriented, and that incorporates non-financial information like ESG and infrastructure. This reformed reporting paradigm highlights the expected role of government reporting: to provide accountability to the public.

Keywords: government reporting; GASB, accountability; Big Data; blockchain; artificial intelligence.

I. INTRODUCTION

This paper proposes a basic set of processes to reform government reporting standards drastically. This drastic transformation shows what reporting is supposed to be attempting for substantive transparency and satisfying most stakeholders. Currently, government reporting is not organized in databases, is not future-oriented, only measures traditional variables, and is issued much after the events. It lacks key features of business reporting, which, by itself, is already very anachronistic. While state-of-the-art applications in many domains are flexible, rich in data and features, and have user-friendly interfaces, reporting has remained with the basic structure that it had when the Securities Act of 1933–1934 was issued, or worse, the methods summarized by Fra Luca Pacioli in 1494 (Pacioli 1494; Sangster 2016, 2018). In this paper, we conceptualize an app-based continuous monitoring and reporting environment that is structured, future-oriented, and deals with Environmental, Social, and Governance (ESG), infrastructure, and real-time information. This reformed government reporting schema could serve as a realistic comparison basis for analysts, policymakers, government entities, armchair auditors, and other stakeholders. The objective is *leapfrogging* the standards and processes of our already-anachronistic business financial reporting.

Government reporting should deal with more than backward-looking financial numbers released much after the relevant event and when the stakeholders can be aware and take corrective actions. It should also be a live mechanism integrating policy objectives and budgeting processes that give rise to the reported numbers. Furthermore, the contingencies of government are very different from business, as two other dimensions are of major importance: (1) the importance and maintenance of the infrastructure, and (2) the quantity and quality of government services. Although the charter, legislation, and some stakeholders of the Governmental Accounting Standards Board (GASB) may not feel comfortable with these dimensions, they encompass a

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data structure linked with an ever-enlarging set of exogenous variables, allowing for "armchair auditing"[1] (O'Leary 2015a; Dai and Li 2016). These exogenous variables are progressively providing stakeholders and government management with ever more significant information needs. Currently, corporate financial statements are published after the fact and have substantive leeway in measurement methods. Fair values estimates expand the scope of measurement flexibility (Ding, Lev, Peng, Sun, and Vasarhelyi 2020). They represent only a minimal subset of the information available/used to run the business. Thus, it is no surprise that an even more considerable gulf exists between government data and its stakeholders.

The OPEN Data laws (e.g., Janssen, Charalabidis, and Zuiderwijk 2012; Conradie and Choenni 2014) are relatively recent, but progressively prevalent. They provide a major opportunity for government reporting at all levels to *leapfrog* the currently more informative, but also terribly anachronistic, reporting schema of business (Alles, Dai, and Vasarhelyi 2021), and it provides a live disclosure schema that satisfies in an integrated manner management, service, maintenance, and stakeholder oversight needs.

The historical framework of government reporting is particularly not useful for accountable leadership and management. Many important policy decisions are seldom backed by pertinent data that are important, leading to politicians not being held accountable in due time for their management/activities/positions (Dai, He, and Yu 2019). Government employees work under many rigid rules that do not emphasize efficiency, effectiveness, or flexibility. By and large, government employees are in very formalized roles that were designed decades ago and often ferociously are protected by the *status quo* and static and dated organizational processes and union rules. Governments in many forms, from federal to state to municipal and independent related organizations (e.g., school districts), work under a large set of historical rules that differ among government organizations (GO).

Government entities are different from business enterprises that face the risk of liquidation or bankruptcy and whose going concern depends on their ability to generate profit. A government rarely needs to consider the risk of liquidation due to its power to collect tax, a lack of market competition, and the need for its services (GASB 2006). The absence of external "threat" may contribute to the lack of incentive for governments to keep improving their reporting methods and infrastructure. Furthermore, the self-interest of players like politicians and career public employees certainly increases the rigidity and aversion from accountability. On the other hand, GOs do not have the direct competitive pressure to avoid disclosing "trade secrets," prices, salaries, and so on. This makes them ideal for experimentation with a broader range of information provisioning and more direct and enhanced accountability.

II. THE MAIN COMPONENTS OF GOVERNMENT REPORTING

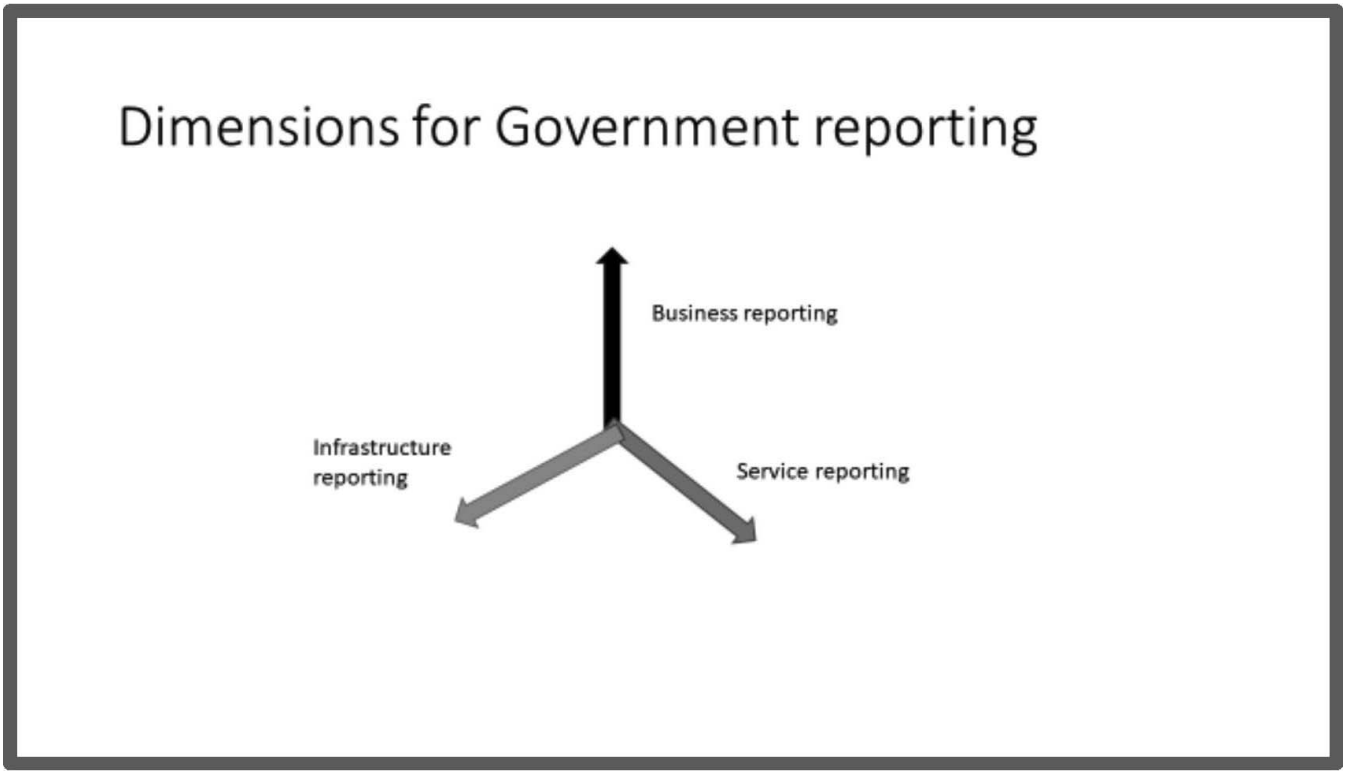
Reporting should be made close to real time (Vasarhelyi and Halper 1991; Alles, Brennan, Kogan, and Vasarhelyi 2018) for continuous variables. It should also present up-to-the-moment measures of the quality of services being delivered (e.g., waiting times for services, the unit cost to the GO for this service, some ranking of the quality of these services). Furthermore, it should present the status of the infrastructure of critical government-provided structures like roads, sewage, water, and the environment that support the well-being of citizens, like air quality (Dai et al. 2019). Figure 1 depicts three dimensions of government reporting: business, service, and infrastructure.

Business Reporting

Government budget and financial reporting continue to be essential, but need to be improved in timeliness and level of detail. Aggregated reports of expenses disclosed six months after the year-end are of limited value. However, clearly stated costs at a higher granular level, out of a live checkbook, or even at creating a purchase or contract signing, that disclose day-to-day what the GO is spending can be of great value. Other factors, such as socioeconomic (unemployment rate, inflation rate, population change), housing market (property tax relief, tax reform), fiscal health-related (bond rating, budgetary impact on current and future service level), and heuristic tools (trend analysis, comparison with other jurisdictions) (Beattie, McInnes, and Fearnley 2004; Copley 1991; Guo, Fink, and Frank 2009; Justice, Melitski, and Smith 2006), could also be included in financial reporting. Furthermore, a real-time comparison of the expenditure with the budget can be attached to armchair audit alerting routines that motivate accountability and provide forward-looking monitoring. The current lack of forward-looking information in key government financial reports leads to a lack of strategic financial planning, where governments are reactive to external events rather than being proactive in their formulating medium and long-range financial plans.

[1] Armchair auditing is a crowdsourcing of informal voluntary analyses on government open data for the purpose of assuring governments' reporting and improving the efficiency of their operational activities (O'Leary 2015a).

FIGURE 1
Dimension of Government Reporting



Service Reporting

There is little, if any, accountability in government services through current reporting standards. Fundamental issues like street cleanliness (Duan, Vasarhelyi, Codesso, and Alzamil 2020a), infrastructure monitoring (e.g., potholes, graffiti, trash) (O'Leary 2013, 2018), and tax collections go unreported and unaccounted. Citizens suffer in poor public services, and neither elected officials nor career government employees are accountable. Modern technologies make disclosure of these indices not only possible, but very cost-efficient. Accountability improves performance and cost-efficiency and leads to greater public trust.

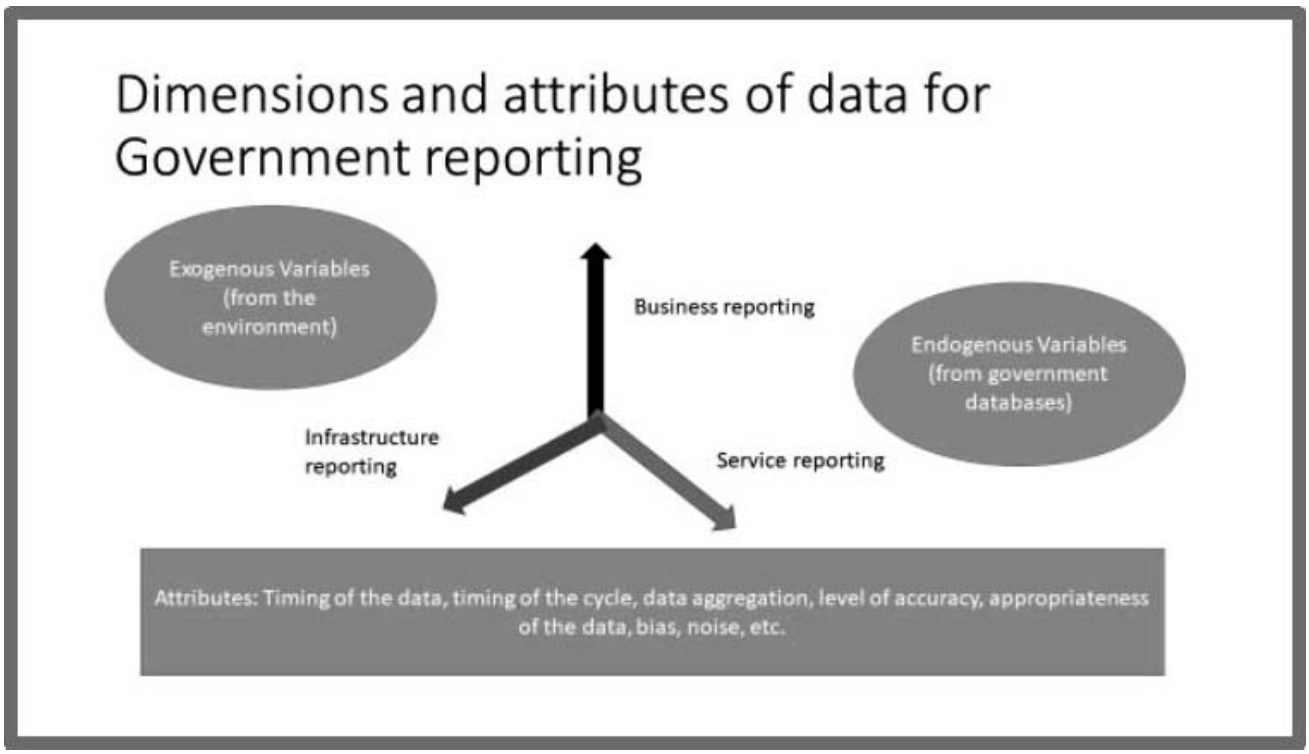
Duan et al. (2020a) use social media utterances for evaluating garbage collection and street cleanliness in New York City. O'Leary (2018) uses crowdsourcing to reengineer the reporting of infrastructure issues and improve the operations and management of the government. London provides its citizens a real-time city monitoring dashboard[2] to indicate information related to the subway, bike availability, weather, air pollutions, traffic conditions, stock market, etc. The "Centro De Operacoes Prefeitura Do Rio" in Rio de Janeiro, Brazil created a live service monitoring system that collects data streams from 30 agencies, including traffic and public transport, municipal and utility services, emergency services, weather feeds, etc. The purpose is to develop predictive models for city development and management (Kitchin 2014). These measures can be used for point-in-time estimation and to look at trends and compare regional performance. Also, this could create competition and accountability among management and service providers. Governments can use other variables (e.g., mobility data, subway turnstiles, images/pictures reported in cloud-based apps, surveillance videos) for a wide range of tertiary measurements like noise, crime prevention, public safety, etc.

Infrastructure Reporting

The triad of government responsibilities encompasses infrastructure. There are issues with its construction, maintenance, and performance of infrastructure. Furthermore, there are severe issues of responsibility and accountability due to the large

[2] See London's dashboard at: https://citydashboard.org/london/

FIGURE 2
Dimensions and Attributes



amounts of investments in infrastructure assets and their safety concerns, as evidenced by recent federal legislation. For example, train tracks and bridges directly affect local welfare, but are often provided by national or state entities and potentially run by independent authorities (e.g., Amtrak and NJ Transit). When problems occur, there is no clear accountability. When revenues decline, localities neglect infrastructure maintenance, as this is less observable. Modern technology can provide satellite photography, x-ray examination of structures with drones, and many sensors (smell, water purity, noise, vibration, radiation, etc.) that can be of great value on infrastructure evaluation. Social media and group sourcing (e.g., traffic) can provide valuable information incorporated into a multidimensional reporting and accountability schema. Australia has created an infrastructure agency (Oswald, Li, McNeil, and Trimbath 2011) to "effectively overcome the many gaps in governance, accountability and performance monitoring, which surround the development and operation of major economic infrastructure projects."

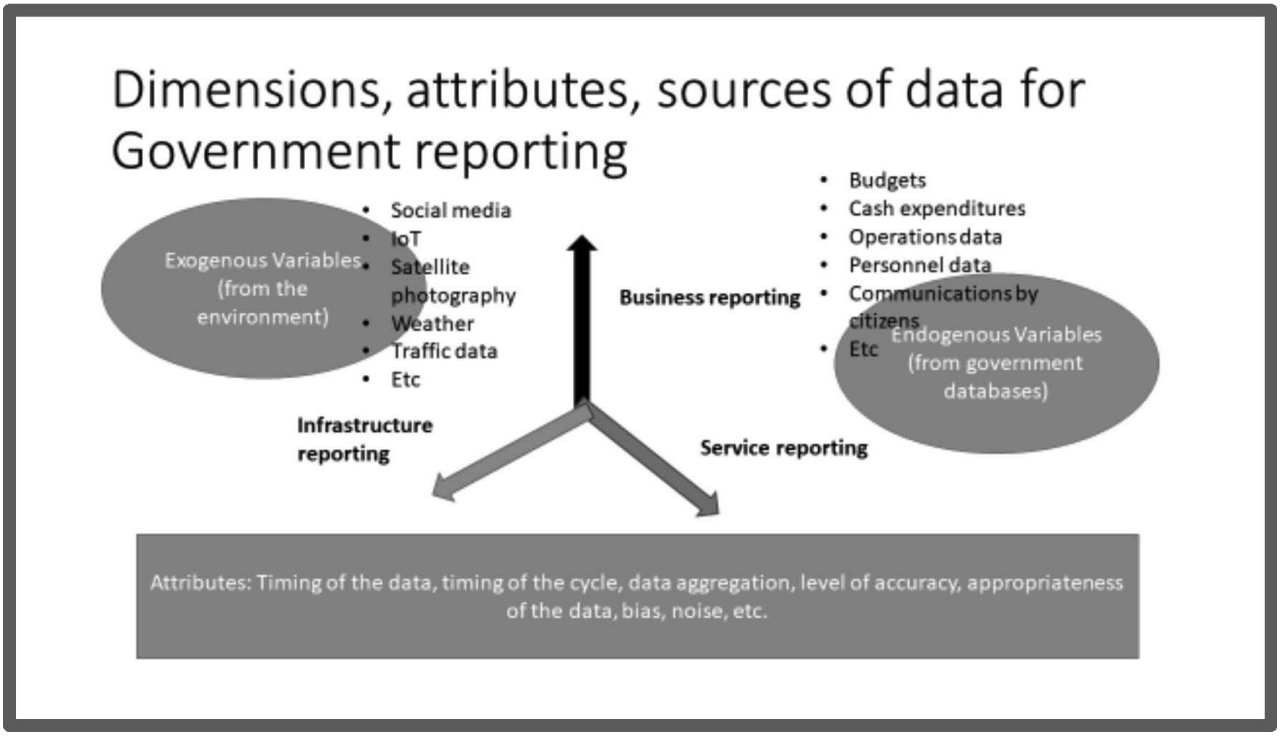
A dynamic reporting schema would rely on both exogenous and endogenous variables, each of these with a wide range of attributes not necessarily homogeneous with different data collection timing, different timing of the cycle, different levels of data aggregation, different levels of accuracy, different levels of appropriateness, bias, etc. (Figure 2). Cho, Vasarhelyi, and Zhang (2019) discuss the data ecosystem and data integration and usage. Coupling different data streams generated for very different purposes, classified according to different taxonomies, presenting different timing streams, measured in different measurement scales, accepting different levels of accuracy, etc., creates serious challenges. Still, these are often just minor difficulties considering the enormous benefits of linking data streams in the age of Big Data.

The world of Big Data, with millions of sources of data with diverse attributes, is illustrated in Figure 3 and Table 1. As an example, a set of applications linked to analytics, predictions, and alerts, as well as management actions, can be imagined.

III. ROLE OF GOVERNMENT AND ITS REPORTING

Using a decentralized governmental model, the federal, and state, and local governments share authority and jurisdiction to provide public services to people. State and local governments have various responsibilities, such as "plan and pay for most roads, run public schools, provide water, organize police and fire services, establish zoning regulation, license professions, and

FIGURE 3
Sources of Data



arrange elections for citizens."[3] People have the most contact with the organizations under the state and local governments' umbrella, including police department, fire department, parks, and recreation.[4] The Governmental Accounting Standards Board (GASB) is responsible for setting accounting standards for state and local governments. In general, government reporting can be categorized into three types: (1) financial reporting, such as the Comprehensive Annual Financial Reports (CAFR); (2) performance-related reporting, such as Performance Audit Reports; and (3). forecast/forward-looking statements, such as Consensus Economic and Revenue Forecast Reports.

Public accountability is a major duty for governments. State and local governments attempt to show their accountability via different reports by disclosing their tax revenue amount and illustrating how efficiently and effectively they spend taxpayers' money and how that expenditure can benefit people's lives (Callahan and Holzer 1999). Financial reports are commonly used to develop different performance measures and determine the accountability of the government, as many of the performance measures are based on quantitative factors. The GASB has issued standards (e.g., GASB Statement No. 34 and subsequent amendments) to provide generally accepted accounting principles (GAAP) for state and local governments' financial reporting to ensure that proper, critical, decision-impact information is provided within the financial reports (Tysiac 2020). Traditionally, government financial reporting was based on a cash basis of accounting to report the budget and operations, which is a conservative way to recognize revenues and expenditures. In 2020, the GASB issued a proposal to change the current government financial reporting model. The new proposed reporting model is designed to provide essential information for decision-making and evaluate the government's accountability (Tysiac 2021). The proposed reporting model is to reexamine the current government reporting standards and assess whether the reporting should focus on short-term financial resources measurement and use the accrual basis of accounting. It also proposed other changes to the management discussion and analysis (MD&A) presentation of the proprietary fund statement, unusual or infrequent items, and budgetary information (Tysiac 2021). Besides the reporting model change proposal, there have been debates and concerns about current government reporting and performance measurement quality. The GASB hosted a public hearing to survey the public opinion about current

[3] See "State and Local Government Responsibilities" at: https://www.theusaonline.com/government/state-local-government.htm
[4] See "State and Local Government Structure" at: https://www.whitehouse.gov/about-the-white-house/our-government/state-local-government/

TABLE 1

Types of Information

Dimensions		
Business	**Service**	**Infrastructure**
Budgets	Garbage collection 311 hotlines	Road condition Bridge condition assessment
Checkbooks	Health and human services	Sewer system conditions
Contracts	Public safety	Public building condition
Financial statements	Education	School debt, other transportation systems
MD&A	Parks and recreation	National Park Service, State Park Service
Audits	Key administrative Functions	Government procurement databases
Environment	Environment protection	Monitors for air quality, water quality, forest coverage, green gas emissions, etc.
Other supplementary information	Emergency rescue services, severe weather alert, amber alert, COVID-19 reporting website	Fire department, national weather service department, AMBER Alert System, COVID-19 reporting system

financial reporting issues and their opinion about the proposed new reporting model. A group of stakeholders sent comment letters[5] in response to the GASB's new financial reporting improvement proposal; some issues and comments raised by the stakeholders are presented in Table 2 with our proposed solutions.

Performance audit reporting is conducted by a government audit entity or a public accounting firm (Generally Accepted Government Auditing Standards [GAGAS] 2018) to evaluate a government program's efficiency and effectiveness, determine the effectiveness of internal control, or the program's compliance status. Generally, a performance audit follows the generally accepted government auditing standards (GAGAS). The audit provides "objective analysis, findings, and conclusions to assist management and those charged with governance and oversight with, among other things, improving program performance and operations, reducing costs, facilitating decision making by parties responsible for overseeing or initiating corrective action, and contributing to public accountability" (GAGAS 2018). This type of reporting provides valuable information to various stakeholders to monitor the government operations. The state governments disclose their performance audit report in PDF format[6] in the public portal.

The forecast or forward-looking reporting consists of several different types of reporting, such as financial planning, revenue forecast, etc. One of the most critical areas is budget reporting, which has important implications for financial resource allocation. States have different methodologies and approaches to determine their budget and revenue forecast for the next fiscal year or the next two fiscal years; it is a legislative process to choose the appropriate budget plan. Most states have a statutory requirement to have a balanced budget, and some states are not allowed to carry over a deficit (National Association of State Budget Officers [NASBO] 2021). Many states have limitations on outstanding debt and strict rules on tax and expenditure limitations to control the growth rate of government revenues and spending (NASBO 2021). Few states require the government to have the appropriation[7] to be less than the estimated revenue (NASBO 2021). The accuracy of the revenue forecast and existing expenditure evaluation would have a significant impact on future government plans.

Existing Government Reporting and Its Inefficiencies

Some, but not all, state and local governments currently prepare the financial report, Comprehensive Annual Financial Report (CAFR),[8] based on GASB guidance and standards, which are recognized as the authoritative standards by state and local governments.[9] However, the GASB is not authorized to enforce the state and local governments to comply with its

[5] See GASB Financial Reporting Model Improvements comment letters at: https://www.gasb.org/jsp/GASB/CommentLetter_C/GASBCommentLetterPage&cid=1176157116776&project_id=3-25&page_number=3

[6] PDF reports are difficult to manipulate and to extract data into comparative databases.

[7] Appropriation provides budget authority for governments to incur obligations. More information can be found at: https://www.govinfo.gov/content/pkg/GPO-HPRACTICE-104/pdf/GPO-HPRACTICE-104-5.pdf

[8] On April 13, 2021, the GASB proposed to change the name to "Annual Comprehensive Financial Report": https://www.gasb.org/cs/ContentServer?c=GASBContent_C&cid=1176176489231&d=&pagename=GASB%2FGASBContent_C%2FGASBNewsPage

[9] See "About the GASB" at: https://www.gasb.org/aboutgasb

TABLE 2

Comments from GASB Financial Reporting Model Improvements Comment Letters and Proposed Solutions

Raised Issues/Comments	Proposed Solutions
• The current financial report is confusing, overly complicated, lengthy, and hard to understand. Need to increase comparability and consistency between governments. • The cost of preparing the annual reports to the individual government entity is high. • Need consistency between governments regarding the definition of operating/non-operating revenues and expenses. • The presentation of Budgetary Comparison information: ○ The debate over presenting the information in the basic financial statements or the Required Supplementary Information (RSI). ○ The debate over the disclosed information whether to compare original budgetary to final budgetary or compare final budgetary to actual results. ○ Supplement the budgetary schedule with an additional statement that provides a view of the natural classifications presented in the budget by reflecting these amounts on the budgetary, short-term measurement focus, and the economic resources measurement focus. • Criteria to determine unusual and infrequent items versus special or extraordinary items.	• To impose a federal-level standardized reporting system (e.g., SAP system for government), disclosure, and reporting format guidance.
• Missing financial outlook of the government entities. • Government reporting needs more public oversight and to reflect the actual financial situation. • MD&A disclosure should remove duplicative information and explanations, increase readability, avoid boilerplate discussion, use plain language, include forward-looking information. • The accuracy of the long-term liabilities disclosure under both current and proposed reporting model. • The proposed new reporting model may mislead stakeholders, provide incomplete government reporting.	• Establishing a dynamic and multidimensional government reporting schemata that incorporates exogenous and endogenous variables with continuous monitoring features and real-time information feeds.

standards (GASB 2021). The issuance of the government financial reports is voluntary rather than mandatory, "only one-third of the 90,000 state and local governments in the U.S. produce annual financial statements."[10] Wang, Codesso, and Issa (2020) find that 31 out of 240 cities in New York State do not prepare the CAFRs or have no financial information disclosed on the official portal. Additionally, the reports are prepared in PDF form and contain scanned images and letters, which are not machine-readable and create complexity for downstream users. In some cases, governments are motivated to prepare their CAFRs to help support their public financing requirements.

Furthermore, most of the CAFRs are stored on individual governments' public portals, and there is no nationwide repository database to store the reports and manage the data governance and maintenance. To collect and analyze the CAFRs, the Continuous Auditing Research Lab (CARLab) at the Rutgers, The State University of New Jersey (Rutgers) Business School worked closely with the GASB to retrieve thousands of CAFRs from the Electronic Municipal Market Access (EMMA)[11] and extract sections of information from the CAFRs to establish a unified database.

In addition, the timely issuance of the state and local governments' audited financial reports has been a concern for many stakeholders. The GASB assessed the timeliness of financial reporting from all 50 states, 100 largest counties, and localities, and 50 largest independent school districts from fiscal years 2006–2008 by hand-collecting the data (Mead 2011). The review results indicate that, on average, it takes approximately 165 days, or five-and-a-half months, for state and local governments to

[10] See "Standard Government Reporting" at: https://xbrl.us/home/government/state-and-local-government/

[11] The governments who issued municipal securities publish their CAFRs on EMMA, which was established for the public to have access to the municipal securities disclosures. However, EMMA only contains a fraction of the available CAFRs, considering the voluntary disclosure condition and the number of municipal securities issuers. EMMA disclosures are in PDF form, keeping them major obstacles to comparability.

FIGURE 4
Large Governments: Days to Issuance

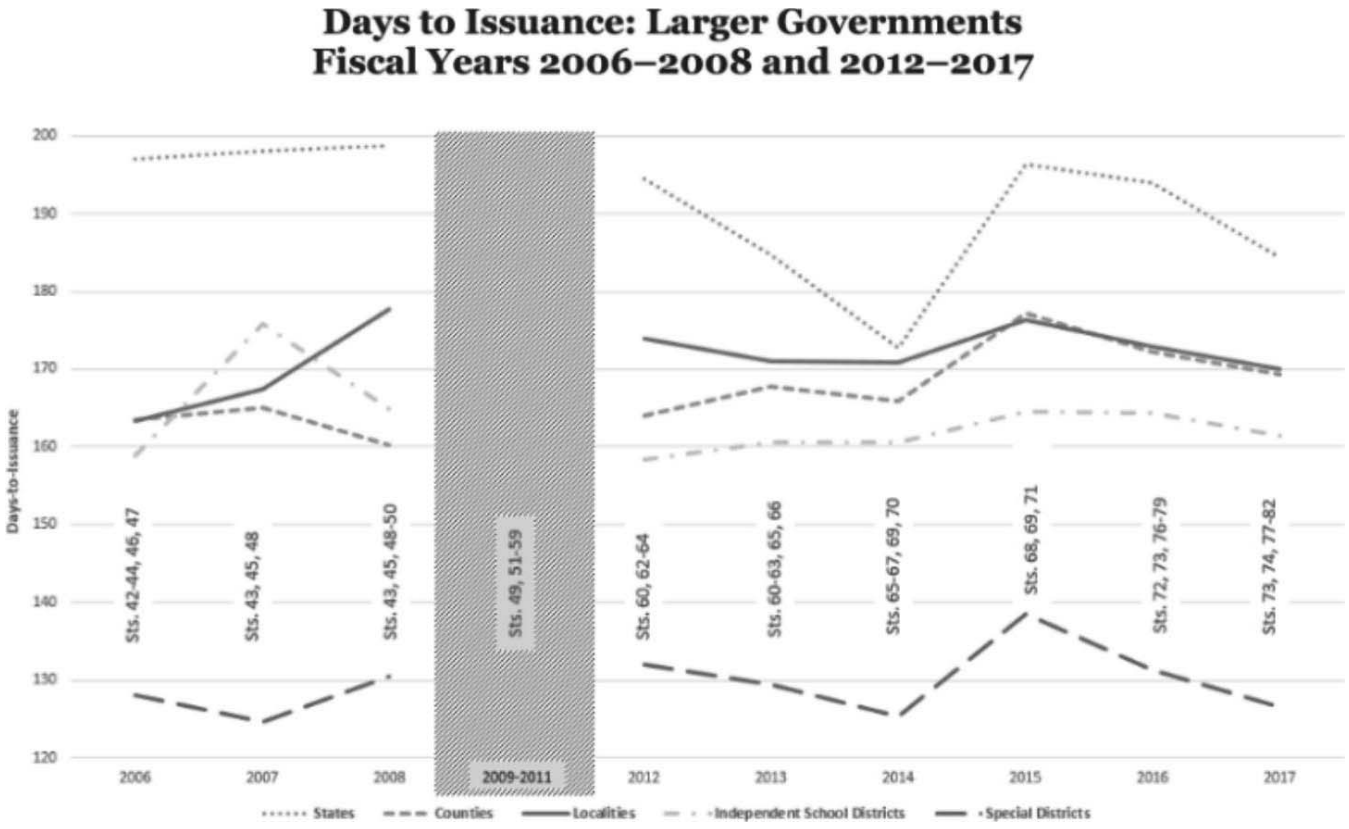


Figure adapted from Dolan and Mead (2019).

issue the financial report after the fiscal year-end (Mead 2011). The time lag between the issuance date and fiscal year-end varies with the type of government.[12] The GASB also noted that the usefulness of the financial report information diminishes as the time lag increases between the fiscal year-end date and the issuance date (Mead 2011). In an age where over 80 percent of stock trading is automated and based on many instant values, and where even business reporting has comparable empirical databases, government reports are rarified, very outdated, and not comparable. Analysts' evaluation of government entities for issuing papers resembles what business analysts did in the 1950s.

A survey (Mead 2011) evaluated the usefulness of government financial information. The results indicate that 89 percent of the participants consider the information very useful if the financial report is issued within 45 days after the fiscal year-end. Only 44 percent of the participants think the information was helpful when the report is issued within three months. Still, less than 9 percent of the participants consider the information is useful when the report is issued within six months after the fiscal year-end (Mead 2011). In a follow-up study conducted by the GASB in 2019, financial reports from the same governments were collected manually from 2012 to 2017. The timeliness of issuance was compared between the two studies; the comparison is based on states, counties, localities, independent school districts, and special districts (see Figure 4 and Figure 5). The average issuance date for the larger state governments is above six months after the fiscal year-end.(Dolan and Mead 2019). All the other types of large governments were below the six-month benchmark (Dolan and Mead 2019). The smaller county governments, on average, took 185 days (2012–2014) or 208 days (2015–2017) to issue the financial report; all the other smaller local governments took an average of less than six months between the issuance date and fiscal year-end date (Dolan and Mead 2019). The GASB has no authority to enforce a deadline regarding the issuance date for state and local governments;

[12] According to the research brief, "the large local and county governments and independent school districts issued their financial reports approximately 6 months after fiscal year-end, state governments were close to 7 months, smaller county governments took approximately 8 months. In addition, 73% of the largest governments issued their reports within 6 months, 2% took longer than a year" (Mead 2011).

FIGURE 5
Smaller Governments: Days to Issuance

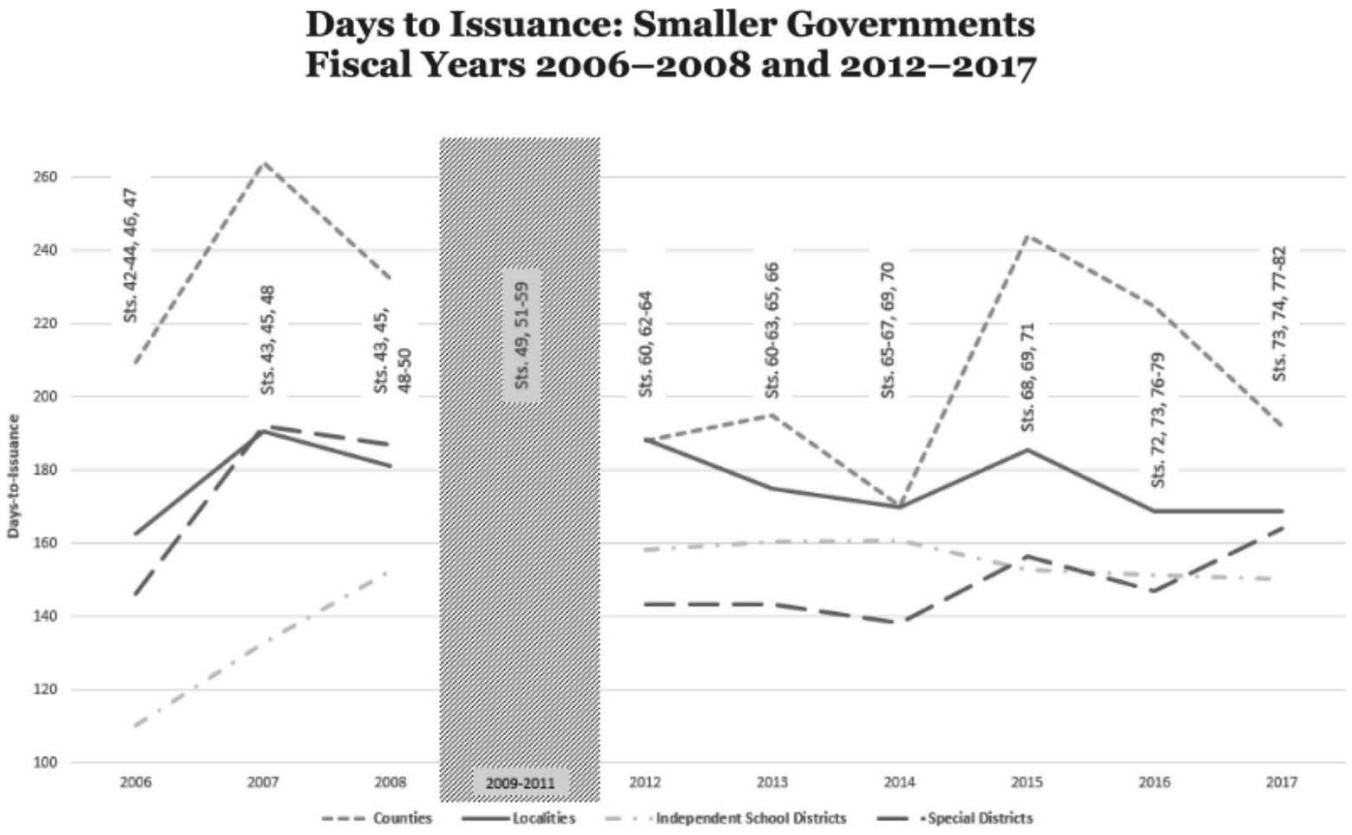


Figure adapted from Dolan and Mead (2019).

in general, six months after the fiscal year-end is commonly considered a reasonable benchmark (Dolan and Mead 2019; Mead 2011). However, the state comptroller offices could enforce a deadline for filings. For example, in New York State, the annual financial report filing deadline is based on the population size for the towns and villages; the deadline is between 60 to 120 days after the fiscal year-end date.[13] A continuous reporting stream would render this issue moot.

Additionally, the disclosure requirements from GASB Statement No. 34 and subsequent amendments to this statement were intended to provide information to determine the compliance status with financial rules, regulations, and laws, as well as the financial accountability of citizens to meet the needs of various stakeholders (e.g., citizens, regulators, investors) (Chan 2001; Yusuf and Jordan 2017). The unintended consequence of a comprehensive disclosure to meet various stakeholders' needs is that the reports tend to be long and complex (Chan 2001), which would raise concerns over the usefulness of the governments' annual financial report (Cournoyer 2012). Researchers have been evaluating the disclosure quality by assessing the readability and similarity of the content as a way to measure the usefulness of the government financial reporting (Wang et al. 2020; Yusuf and Jordan 2017; Guo et al. 2009). Wang et al. (2020) analyze the usability of the MD&A section of the CAFRs issued by New York State from 2015 to 2019. The study finds that the MD&A disclosures over the period have low readability and high similarity, which means that primary users have difficulties understanding the content, and the variation of the MD&A content over the examined period is low (Wang et al. 2020). Guo et al. (2009) assess the disclosure quality of the MD&As from 43 large cities in Florida. The study finds that the content has considerable variations; however, some MD&As disclosed similar information, only a few MD&As mentioned significant information, such as pension and trends after the prior fiscal year, or a benchmark from other jurisdictions (Guo et al. 2009).

[13] See the New York State annual financial report filing deadlines at: https://www.osc.state.ny.us/local-government/required-reporting/annual-update-document-annual-financial-report-filing-deadlines

The current government financial report mainly focuses on past events, cannot fully provide information about the sustainability of the government, the outlook of the financial condition, issues with future revenue streams, etc. It lacks forward-looking information that can be used as an early signal for stakeholders to take preventive actions. Currently, the government performance measure is primarily based on the quantitative financial indicators to evaluate and monitor the government operations, budgets, financial and operation reports, and legislative hearings (Wang 2000, 2002; Rivenbark and Kelly 2006).

Other Obstacles in Government Reporting

The public sector's obstacles to modernizing its accounting and reporting mainly include a lack of talent and funding. Recently, the federal government has realized the importance of transforming agencies through data and analytics. In a newly conducted survey of 283 public sector professionals, 78 percent of respondents said that data are a significant component of their work and 60 percent said that the extent to which they base decisions on data is above average (Fiorenza 2021).

However, federal managers worry that prospective public sector employees lack the required analytical skills and technical proficiency to analyze the federal government's large and complex datasets (Fiorenza 2021). At the same time, public sector employees do not feel well prepared to use the government's data (Fiorenza 2021) efficiently. A significant reason for the lack of analytics skills in public sector employees is that the education system does not provide proper training (Fiorenza 2021). Furthermore, it is challenging for governments to attract and retain analytical talents compared to private sector companies.

Besides a shortage of talents, governments also struggle to allocate enough funding to modernize their reporting methods and infrastructure (Fiorenza 2021). Currently, government data are scattered through multiple systems with non-standard formats. It will take a significant amount of time and effort and, thus, funding to integrate data from different systems and pre-process it to be ready for analysis (Fiorenza 2021). Furthermore, establishing modern infrastructure and hiring analytics talents also requires much funding. States and localities feel that increased information requirements are costly and burdensome. Brazil has substantially dealt with this problem through the federal government providing pre-set software and standards to municipalities at no cost except local labor.[14] Emerging technologies may serve to dramatically facilitate a much more comprehensive information positioning for all GOs, at minimal cost for entities, if standardization may happen.

IV. STATE-OF-THE-ART TECHNOLOGIES AND THEIR POTENTIAL ROLES IN GOVERNMENT REPORTING

This section introduces emerging technologies that can affect significant aspects of government reporting (e.g., CAFR, performance-related reporting, and forecast/forward-looking statements). These technologies include exogenous Big Data and analytics, blockchain and smart contracts, and artificial intelligence.

Exogenous Big Data and Analytics

The digital transformation creates a dynamic data environment, bringing evolution and revolution to entity operations, business measurements, and assurance. Advanced emerging technologies allow organizations to decide based on data-driven algorithms and explore the value of data beyond the organization's internal data source. Various data sources have been proposed in the literature and are progressively adopted in business. These sources include social media, mobility data, web data, Internet-of-Things (IoT), weather data, location data, click data, search data, etc. (Vasarhelyi, Kogan, and Tuttle 2015; Brown-Liburd and Vasarhelyi 2015; Duan et al. 2020a; Rozario and Vasarhelyi 2019; Yoon 2016; Duan and Hu 2021; Duan, Hu, Vasarhelyi, Da Rosa, and Lyrio 2020b).

Many of the applications of exogenous data generate business values, such as companies using consumers' purchase behaviors or web browsing history to predict consumers' future behavior and develop the targeted business strategies to meet those needs. However, the value of exogenous data can be more than for business purposes (Brown-Liburd, Cheong, Vasarhelyi, and Wang 2019). For example, Duan et al. (2020a) analyze the sentiment of tweets to assess the cleanliness of New York City streets; the study provides the municipality an alternative performance measure to improve their operational efficiency and effectiveness. Johnson and Bowers (2004) and Johnson et al. (2007) utilize burglary data and a clustering approach to analyze the crime patterns and predict the potential future instances to direct the police force. Duan and Hu (2021) and Duan et al. (2020b) utilize different exogenous data (e.g., social media, Google Trend, Apple Inc.'s mobility reports, official announcements, subway turnstile data) to validate the publicly disclosed pandemic-related information (e.g., confirmed cases, positive percentage rate), as well as predicting future pandemic development. O'Leary (2013) presents a case study of utilizing a mobile device app to collect Big Data regarding the City of Boston's roads and repairs. The study demonstrates an

[14] See: https://siconfi.tesouro.gov.br/siconfi/index.jsf

example of using emerging technology and exogenous data to facilitate a continuous monitoring system for the city's road infrastructure. Subsequently, the City of Boston implemented a cloud-based mobile app to encourage public engagement and monitoring of the city's infrastructure (O'Leary 2018).

Brown-Liburd et al. (2019) propose the Big Data-based Government Economic Monitoring (GEM) methodology to "replace outdated blanket government intervention programs." GEM's approach is to monitor and track various exogenous data, extract valuable information from collected exogenous data based on socioeconomic measures, and prescriptively direct appropriate government actions to meet societal needs (Brown-Liburd et al. 2019).

Another example of how governmental agencies can utilize Big Data to provide better service to the public is the International Organization for Migrants (IOM). IOM is an inter-governmental organization that promotes international cooperation on migration issues and provides humanitarian assistance to migrants in need.[15] During its disaster relief of Super Typhoon Haiyan in the Philippines in November 2013, the IOM adopted text mining analysis to process more than 10,000 tweets (Fiorenza 2021). The social media data provided important details about the relief efforts' status and informed what resources were most urgently needed, such as antibiotics and generators (Fiorenza 2021).

By establishing dynamic government financial reports using exogenous data, governments can better assess the reasonableness of their budgetary plan and proactively evaluate the budget spending progress based on real-time information, potentially creating a Continuous Monitoring (CM) system for budget planning and assessment.[16]

State and local governments have the privilege that other entities do not have to obtain and request exogenous data from various sources (Brown-Liburd et al. 2019). Ubiquitous data can be utilized, monitored, and provide feedback so that the government to allocate resources efficiently. The information can also be part of the financial reporting and improve the quality of the financial report. For example, GASB Statement No. 34 requires the government to disclose if there is a credit rating change for long-term debt. However, disclosing subsequent events that may potentially impact the government's future revenue streams, particularly data from a news outlet or other source of exogenous data, will provide an early warning for the government's stakeholders. Another example is that the progress of infrastructure and maintenance requests from citizens could better direct the budgetary process and track the service offered. A feedback loop can be created with proactive GEM action by GOs and crowdsourced citizen utterances being used to affect GEM action (O'Leary 2013, 2015b, 2016, 2018, 2019).

Blockchain and Smart Contracts

Blockchain is considered one of the most transformative information technology innovations in recent years (Dai and Vasarhelyi 2017; Zhao, Fan, and Yan 2016). Blockchain was initially known as a core concept and underlying technology of Bitcoin transactions (Nakamoto 2008). After being quickly adopted by a variety of fields, blockchain now essentially serves as a secure shared database. It features decentralization, non-tampering, traceability, joint management, and maintenance and transparency across a network of computers (Fanning and Centers 2016; Pilkington 2016; Swan 2016). Because of those features, it is further explored in various business and social areas, such as asset registration, supply chain management, financial auditing, electronic insurance contracts, and auditable voting systems (Dai and Vasarhelyi 2017; Min 2019; Raikwar et al. 2018; Swan 2016).

The use of blockchain has been further augmented by its integration with smart contracts (Zou et al. 2019). Smart contracts are programs embedded in blockchains that autonomously execute the pre-set terms and rules in the contracts (Kiviat 2015; Peters and Panayi 2016; Zhang, Cecchetti, Croman, Juels, and Shi 2016; Zheng et al. 2020). Related parties encode rules into smart contracts, which are deployed on a blockchain and shared with every computer on the blockchain. Those computers then reach a consensus based on the consensus algorithm of the blockchain and jointly execute terms in the contract. Such a mechanism could prevent malicious activities from individuals and even collusion from a small group of organizations (Dai et al. 2019).

The government could benefit from the blockchain and smart contracts to solve many problems existing in the reporting process discussed in previous sections. For example, blockchain shares and verifies data in real time so that each stakeholder can obtain reliable information when needed. In addition, transactions on a blockchain are supposed to be immutable and traceable, which could be used as trustable evidence to trace the government officials or agencies who published a piece of information or took an action and, therefore, help enhance the accountability of government entities. Furthermore, smart contracts could help automate steps in the reporting process based on predetermined reporting rules to enforce complete, accurate, and timely reporting, as well as prevent errors or fraudulent activities made by humans (Kim, Lyrio, Dai, Rosa, and

[15] See: https://www.iom.int/about-iom

[16] Continuous Monitoring (CM) is "a process by which online/real time systems are used to manage, on, or close to a real-time basis, the performance of corporate processes" (Turoff et al. 2004). The main purpose of CM is to timely detect "significant variances from expected performance with resulting rapid intervention and corrective action" (Turoff et al. 2004).

Vasarhelyi 2021). Smart contracts could also promptly release tailored information to interested users based on their demands, positions, background, and preferences if those were pre-set in the contracts.

Artificial Intelligence (A.I.)

A.I. is the theory and development of computer systems that can perform tasks that typically require human intelligence (Russell and Norvig 2002; Institute of Electrical and Electronics Engineers [IEEE] 2019). Common A.I. technologies include machine learning (ML), natural language processing (NLP), computer vision, and robotics (Russell and Norvig 2002). Although A.I. is not new to the public sector, recent development in computing power and availability of Big Data has fueled more efficient, effective, and cheaper adoption of A.I. technologies. Each type of A.I. technology has the potential to be used in government reporting.

The current core to A.I. is ML, a computational method that can identify hidden patterns from data and make predictions (Hastie, Tibshirani, and Friedman 2009; Alpaydin 2020). Since the main function of ML is to make predictions (Alpaydin 2020), it may be particularly useful in government reporting aspects that involve forecasts, such as forward-looking reporting, performance forecasting, and budget planning. For example, in the process of government budget planning, ML can be used to predict future revenues (e.g., tax collections) and expenditures. These predictions then can be used in a continuous monitoring/continuous audit mode (Vasarhelyi and Halper 1991; Alles, Kogan, and Vasarhelyi 2008). The predictive feature of ML may be especially useful to enhance the operational accountability of governmental reporting, which emphasizes a long-term perspective of government decisions. In performance forecasting, ML, coupled with exogenous Big Data, can be used to detect government cyber anomalies (e.g., Musser and Garriott 2021), predict failure rates of public equipment/infrastructure (e.g., military equipment) for real-time monitoring and timely maintenance (e.g., Celikmih, Inan, and Uguz 2020), and to monitor in real time street cleanliness (e.g., Duan et al. 2020a).

Computer vision is an A.I. technology that enables computers to obtain information from images or videos (Szeliski 2010). Computer vision can often be coupled with other technologies, such as drones and robotics, and it has already been used in applications like video surveillance, optical character recognition (OCR), fingerprint recognition, and machine inspections (Szeliski 2010). In government reporting, computer vision may help reduce mundane tasks related to information extraction from images/video. For example, OCR can be used to convert scanned documents, such as invoices, into editable word documents; drones with computer vision can be sent to remote or dangerous sites for performance monitoring and management purposes; machine inspection functions can be used to assess the condition of public equipment like sewer systems and train rails.

NLP technologies can be used to efficiently process textual information (Chowdhury 2003). Government reporting often contains textual information, and NLP can be used to analyze such information. For example, Wang et al. (2020) use NLP to analyze the MD&A section of governmental reporting to examine its readability and informativeness. Duan, Hu, Yoon, and Vasarhelyi (2021) analyze CAFR reports from New York, New Jersey, and California in terms of their compliance to GAGAS and their readability and informativeness. NLP may be extensively used to facilitate the resolution of the discontinuities of the data ecosystem. NLP can also help the government provide more efficient services to the public. For example, the U.S. Citizenship and Immigration Services (USCIS) uses Emma, a computer-generated virtual assistant, to answer questions and direct individuals to the right area of the website.[17]

Another subset of A.I. is automation and robotics. Besides mechanic robots, recent years have seen a surge of technology that makes the automation of knowledge work more feasible and accessible. Robotic Process Automation (RPA) is a technology that enables the automation of repetitive, standardized, structured, and rule-based tasks on one or multiple software platforms (Willcocks, Lacity, and Craig 2015; IEEE 2017). Compared to other automation technologies, RPA is user-friendly and can run applications in the same way a person works with that software (Lacity and Willcocks 2017; Gartner 2019). While using software to automate knowledge workers' tasks is not a new idea, RPA makes automation more feasible, cheaper, and quicker (Hofmann, Samp, and Urbach 2020). RPA has been used in the private sector, such as banking and finance, insurance, manufacturing, and healthcare, to automate repetitive processes like invoice processing, payment allocation, and reconciliation. In the same vein, RPA can also help public sectors reduce redundant and time-consuming tasks, reduce costs, and improve productivity (UiPath 2019), especially that government sector workers often manually process large amounts of data collected from government operations and other government sectors, such as military and aerospace. For example, RPA has already helped public agencies automate processes like management of welfare, pension, and child maintenance policy, public records inquiries, and background checks (UiPath 2019). Adopting automation A.I. technologies not only can enable public sector

[17] See: https://www.uscis.gov/tools/meet-emma-our-virtual-assistant

TABLE 3

Technologies and their Application in Government Reporting

State-of-the-Art Technologies	Potential Applications in Government Reporting
Big Data and Analytics	Develop predictive models based on streams of exogenous data, such as crime pattern, traffic control, garbage collections, infrastructure repair. • Systematically assess the required resources based on real-time data and predict future needs. • Construct a dynamic expenditures analysis based on historical data and peer group information. • Facilitate a continuous and prescriptive real-time monitoring agent to direct the governments' action. • Promote a sustainable, productive, and transparent governmental action plan.
Blockchain and Smart Contracts	• Property transactions. • Tax compliance and collection. • Property and general fixed assets management. • Data verification, monitoring, and sharing. • Accountability tracing. • Tailored reports to stakeholders.
Artificial Intelligence	• Use ML to make predictions on expenditures and other related accounts. This process can be enhanced with big exogenous data. • Use computer vision for document processing and government operation surveillance. • Use NLP to process textual Big Data (e.g., tweets) to perform real-time monitoring of street cleanliness. • Use RPA to automate mundane government reporting tasks such as (UiPath 2019): ○ Public records inquiries. ○ Welfare, pension, and child maintenance policy management. ○ Background checks. ○ Document management. ○ Financial and accounting processes. ○ Sustainability assessments. ○ Regulatory Compliance.

employees to focus more on high-value-added tasks, but also can potentially improve government reporting efficiency and quality.

A potential challenge of A.I. application in governmental accounting and reporting is its complexity and lack of transparency. Since governmental reporting emphasizes accountability and citizens' "right to know," it is vital to explain how A.I.'s application affects the governmental reporting process. An emerging area of Explainable A.I. (XAI), which develops techniques to add interpretations to opaque A.I. applications (Defense Advanced Research Projects Agency [DARPA] 2016), may make governments' adoption of A.I. more justifiable.

A summary of the above state-of-the-art technologies and their potential applications in government reporting is presented in Table 3.

V. A MODERN GOVERNMENT REPORTING SCHEMA

Machine Readable and Standardized Government Data

In 2014, the Digital Accountability and Transparency Act (DATA Act) was passed to promote transparency and accountability in federal spending. It mandates the federal government to standardize data elements and publish all the financial data as a standardized, machine-readable form to the public (U.S. House of Representatives 2014). Subsequently, the Open Public, Electronic, and Necessary (OPEN) Government Data (OGD) Act was passed in 2017, requiring all federal agencies to make government data available in machine-readable form.[18] State and local governments are trying to follow the federal government's effort to create an open data portal. However, only 17 states made data open as required by law.[19] Overall, the

[18] See the OPEN Government Data Act at: https://www.congress.gov/bill/115th-congress/house-bill/1770

[19] See "State Open Data Laws and Policies" at: https://www.ncsl.org/research/telecommunications-and-information-technology/state-open-data-laws-and-policies.aspx

open data environment fosters government reporting transformation and promotes public monitoring from the "armchair auditors."

One of the requirements for open data is to have data in machine-readable form. In general, machine-readable form means the computer can efficiently process the data without human intervention, such as HTML, XML, and CVS file formats. However, most published reports are in PDF format, which is not machine-readable and requires human intervention to extract information. Although the PDF reports are publicly available, they are difficult for stakeholders to use and find relevant information. PDF disclosure is probably the major obstacle to the existence of large comparable reporting databases. It substantively hinders the application of many types of analytics emerging in many areas of accounting (Appelbaum, Kogan, and Vasarhelyi 2017a; Appelbaum, Kogan, Vasarhelyi, and Yan 2017b). The Standard Government Reporting Working Group[20] chose the eXtensible Business Reporting Language (XBRL) to be the reporting language for the open data of the state and local governments. Adopting XBRL reporting in the public sector is a challenge as no single regulatory agency has the authority to implement a nationwide public sector reporting mandate (Joffe and Reck 2019).

Example: Brazilian e-Invoicing

In Brazil, all enterprises are required by the government to use electronic invoicing (or e-invoicing).[21] The e-invoicing follows a standardized format called Nota Fiscal Eletrônica (or NF-e). When a transaction happens between a seller and a buyer, the seller will generate an Extensible Markup Language (XML) document. This invoice needs to be digitally signed by the seller. Next, the e-invoice will be sent to the tax authority to be validated and authorized. Last, the validated e-invoice will be sent to the buyer, together with the product or service ordered by the buyer.[22] The e-invoicing schema has increased the efficiency of the governmental administrative process, reduced costs, reduced time sending and collecting invoices, increased security of commercial transactions, and automated the processes of reception and integration of invoices.[23] This e-invoice system (used in Brazil, Chile, and Mexico) is being used to enhance fiscal control. It enables a more accurate and complete collection of tax revenues and facilitates timely and more accurate information-gathering about the economy.[24]

Government Reporting 4.0 and Continuous Monitoring

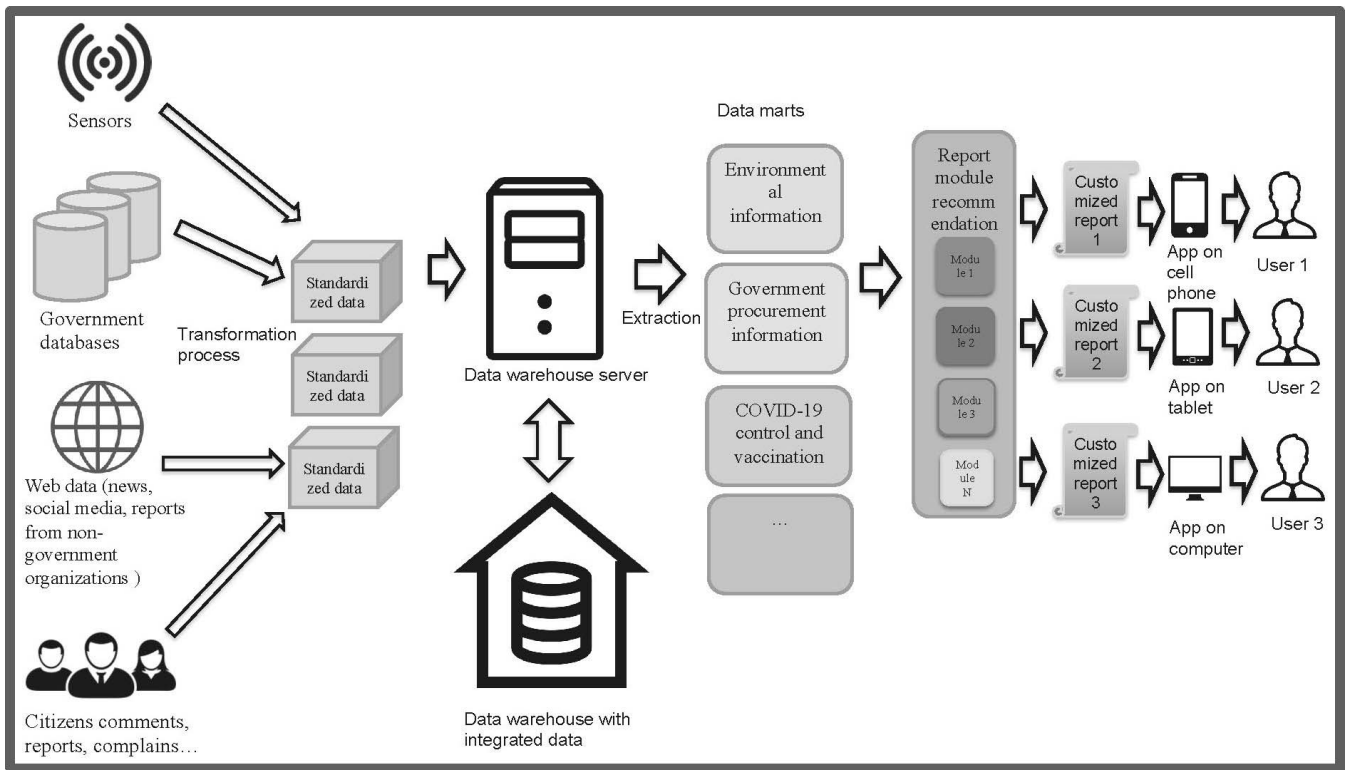
Alles et al. (2021) proposed a comprehensive, timely, and predictive business reporting model named Reporting 4.0. Reporting 4.0 uses an app-based mechanism, which "will support the myriad objectives of modern enterprises and their diverse stakeholders with contemporary measurement methods, mode encompassing information, and analytics that can be retroactive, current, and forward-looking" (Alles et al. 2021). Although Reporting 4.0 is initially designed for corporate reports, its goals, characteristics, and principles could be leveraged to create a Government Reporting 4.0 schema. One prominent feature of Reporting 4.0 is that *users* decide the content in a report, rather than producers. This characteristic could reduce information overload (Schneider, Dai, Janvrin, Ajayi, and Raschke 2015), which distracts users from key information in decisions. Such a problem is pervasive in the era of Big Data, in which more data are being collected in two years than in the previous 2000 years (Syed, Gillela, and Venugopal 2013). The core of the modern government reporting schema could be designed as a comprehensive data warehouse. Data from a variety of sources are collected and integrated into data marts targeting particular stakeholders. These are then extracted and packaged into information modules, pushed to appropriate users based on their roles, decision-making strategies, preferences, etc. Figure 6 displays a potential design of Government Reporting 4.0.

In Figure 6, Big Data from sensors, government databases, the web, citizens, etc., would be collected as the information foundation of the Government Reporting 4.0 schema. Sensors embedded in many public facilities would capture the temperature, humidity, pressure, movement, etc., of the physical objects and their surrounding environment. For example, air-condition sensors could capture the air quality across a city and create a heatmap of air pollution (Dai et al. 2019). Government databases would provide information regarding activities of each government agency, such as contracting and procurement processes (Dai and Li 2016), fund spending, COVID-19 vaccine management, etc. Web-crawlers would also be used to crawl news, social media, and reports from non-government organizations to collect content regarding government performance and evaluation. Citizens' comments and complaints posted on government websites or other open platforms would also serve as an essential information source to evaluate government performances when integrated with additional information.

Data collected from the sources above might have different formats, field names, and structures complicating the later integration and analysis processes (Dai 2017). Data should be standardized and transformed to a format understandable by the

[20] See "Standard Government Reporting" at: https://xbrl.us/home/government/state-and-local-government/
[21] See: https://www.edicomgroup.com/en_US/solutions/einvoicing/LATAM_einvoicing/brazilian_einvoicing.html
[22] See: https://www.edicomgroup.com/en_US/solutions/einvoicing/LATAM_einvoicing/brazilian_einvoicing.html
[23] See: https://marketing.edicomgroup.com/INT/whitepaper-239en_eInvoicingLATAM.pdf
[24] See: https://marketing.edicomgroup.com/INT/whitepaper-239en_eInvoicingLATAM.pdf

FIGURE 6
A Potential Design of the Government Reporting 4.0



data warehouse. Then, standardized data would be integrated and stored in this data warehouse. Data are then accessed through a server that would provide search, process, analysis, and predictive functions. The complex dataset in the data warehouse would further be organized as small units of "data marts," where "each data mart is dedicated to the study of a specific problem" (Ghezzi 2001) to accelerate the reporting process.

For example, a data mart could gather environmental-related data to report the government's performance on climate change and environment protection. Another data mart could analyze government procurement activities and report potential bribery cases. A third data mart could monitor government actions on COVID-19 control and vaccine management. Each of the data marts would then be packaged into an information module with user-friendly interfaces. Interactive visualization would allow users to explore the information in their preferred way. For example, users could drill down from the national level of COVID-19 control costs to the spending of each state or county using the interactive geographical function. Once information is in focused, problem-driven modules, it is recommended to users to make effective decisions. These information modules can be posted to a transaction in a blockchain that is accessible close to real time. However, different access privileges should be well defined and granted to users of different roles and purposes. For example, citizens might be given access to an air-quality module, but no access to the salaries of government employees.

The different roles, background, goals, decision-making strategies, etc., of government report users might result in differences in information demand and preferences. For example, citizens would care more about the pollution in their area, while investors would pay more attention to the policies and activities that government would take to reduce greenhouse gas emissions and their impacts on firms' costs and profits. As a result, users desire tailored information contributing to their decision-making, rather than overwhelming data that distract their attention. A recommender system (Dai and Vasarhelyi 2020) can be used to select for each user the most desired module and sort based on the likelihood of its use in decision-making (Alles et al. 2021). Finally, a series of sorted information modules would form a customized report to be pushed to the reporting app in users' cell phones, tablets, or computers.

The information modules could provide timely, accurate alerts of abnormal events when embraced with Continuous Monitoring (CM). Embedded information modules monitor the data collected for particular events, comparing them with expected values or ranges and sending abnormality alerts. In addition, predictive audit analytics (Kuenkaikaew 2013) may be

integrated into a CM model to enhance the accuracy of the estimations on typical values or ranges. Information users can create smart contracts to enable CM. Contract terms specify the types of alerts they need, the materiality of the information (e.g., a threshold where air quality is worse than expected), and the timing of their reports. Smart contracts would automatically enforce the reporting process to ensure information's completeness, accuracy, and timeliness.

VI. MOVING FORWARD

Governments should consider reporting schema reform to rationalize their data requirements and provide healthy accountability and incentives for good governance. The Dutch government[25] adopted its standardized business reporting approach integrating financial, tax, and statistical reporting, dramatically simplifying the information value chain. In a limited form, the Australian and British governments attempted the same. This paper proposes a much-enlarged schema taking into consideration modern reporting technology and the needs of multiple stakeholders. At its core, this would require increased investment in modernizing governmental reporting and attracting and retaining talents with analytics skills.

Increase Investment

The federal government should provide adequate funding to support (1) research and development in reforming government reporting schema; (2) development of state-of-the-art reporting infrastructure to facilitate timely and ready-to-process governmental reporting; and (3) adoption of emerging technologies like A.I., RPA, blockchain, and Big Data analytics to promote an automated and data-driven disclosure that extends to Environmental, Social, and Governance (ESG) and futuristic reporting.

Attract, Cultivate, and Retain Talents

Since both the public and private sectors compete for analytical skills or science, technology, engineering, and math (STEM) backgrounds, the federal government must attract and retain these talents. To make public sector jobs more appealing to prospective employees, federal governments need to offer competitive compensation and benefits compared to the private sector. Furthermore, the government can also cultivate analytics skills among its existing employees. This can be done by training and supporting further part-time education or providing funds to college students willing to work for the governments to pursue analytics-related degrees. Last, to maintain these talents, the government also needs to provide skilled employees with competitive opportunities for career advancement.

Provide a Standardized and Free Platform and Apps for GOs

The Government Reporting 4.0 schema design in this paper (Figure 6) provides a potential solution for governments to improve the transparency, timeliness, and accuracy of the reporting process. Building on the standardized data platform, governments could collect, integrate, and share a variety of information in real time via reporting apps to their stakeholders. This service should be open to the public, media, professional associations, and anyone interested in government operations to utilize those reports for further analyses and investigations.

VII. CONCLUDING REMARKS

The new schema of government reporting proposed in this paper utilizes leading-edge technology. It is a product of invention and imagination, and it is currently substantially unexplored. The exploration and implementation of this new schema will depend not only on substantive research, but also on experimentation and adjustments that existing legislation and regulation do not easily allow. The basics of reporting methods remain fundamentally the same as those from a very different technological environment. However, the era of Big Data and interconnectivity requires flexible regulation methods and rules that can enable standardized and automatic reporting across the world. Krahel (2012) argues that computers are not very good at dealing with principle-based accounting, but can deal with formal and deterministic accounting rules. In light of this discussion, standardization and formalization are necessary under current technology, such as pre-standardized software provided by the government that enables universal and automatic execution. Smart contracts (Coyne and McMickle 2017; Dai and Vasarhelyi 2017) can place rules and regulations embedded into blockchains. These may only be changeable by regulators.

[25] See: https://business.gov.nl/regulation/standard-business-reporting/

Future Research

What Ethical Issues Could Emerge in the Proposed Government Reporting Schema?

Governments range from highly liberal to totalitarian and from good technological implementers to neophytes. An even more comprehensive set of ethical, moral, and libertarian issues can arise with extensive government reporting, GEM action, and automatic rule adjustment.

Which Strategies Should be Taken to Alleviate the Associated Risks?

International guidance and monitoring can be instituted, and technological learnings and code can be shared, for example, by multi-state organizations like the United Nations and the European Union. Watchdogs can be created to monitor and reveal exploitative and biased reporting and predictive systems. Packaged government management and technological reporting solutions (PGMRS), encompassing enterprise resource planning (ERP), reporting platforms, analytics, special reports, and apps, can be created and only shared in object code, making modification difficult. Code can be inserted to detect an unauthorized change and to freeze it in case of abuse. Contractual terms of code sharing can include protections.

How Can Privacy be Protected and Transparency be Maintained?

General Data Protection Regulation (GDPR) has clauses of public good where these considerations override privacy. The current pandemic has made governments' usage of locational information acceptable by many countries. It is unavoidable that the use of detailed information, analytics methods, prediction models, automatic action modules, and feedback technology to make models self-improving will have unresolved/unresolvable privacy implications. Culture and political regime will resolve some of these issues, but will make some decisions made on the design of the PGMRS seem arbitrary and difficult to accept. This will be, for many governments, a decision between the adoption of incredibly beneficial software solutions and the abdication of some national desires. Designers of PGMRS may opt to allow local parameterization of some factors. An even more comprehensive set of ethical issues will arise with the GEM framework.

How Can Data from a Variety of Sources be Standardized and Integrated?

The ecosystem of data from many sources of Big Data will, for a long time, be a major difficulty and source of disagreement among users, data providers, and developers. Much research is needed in the development, homogenization, and usage of data from many sources (Cho et al. 2019). This problem, and its economic costs, will continue to exist and will become more significant. Many packaged technological solutions will emerge to help.

There is an increasing need for government accounting standard setters to recognize the impact of their activities on the potential use of leading technologies to promote greater accountability. These standard setters must consider their work to further the discussion and research on how their reporting standards can either hamper or promote such a transformation. In the U.S., both the Governmental Accounting Standards Board and the Federal Accounting Standards Advisory Board have constituencies that can benefit from this effort.

In summary, current reporting schemata are obsolete and need to be reformed to improve business and government reporting. The government area seems more adequate to leapfrog business reporting in development as it does not have the same competitive and privacy limitations that are present in business. Furthermore, recent developments in open data denote the openness of governments to present operational data to the "armchair auditor." This paper starts a process of discussion of a major paradigm change in this area.

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