TECHNICAL

NOTES & MANUALS

Digital Solutions Guidelines for Public Financial Management

Lorena Rivero del Paso, Sailendra Pattanayak, Gerardo Uña, and Herve Tourpe

TNM/2023/07

TECHNICAL NOTES AND MANUALS

Digital Solutions Guidelines for Public Financial Management

Lorena Rivero del Paso, Sailendra Pattanayak, Gerardo Uña, and Herve Tourpe

Authorized for distribution by Ruud de Mooij

The authors received excellent support from Chloe Cho, who helped with research, organization of the pilots, and development of the Digital Solutions Guidelines Implementation Tool (DiGIT). These guidelines also benefited from contributions by Soheib Nunhuck and Frankosiligi Solomon to the information technology (IT) architectural principles, and the staff of the Legal Department of the IMF who contributed to the Governance and Management Pillar.

Cover Design: IMF Creative Solutions

Cataloging-in-Publication Data
IMF Library

Names: Rivero del Paso, Lorena, author. | Pattanayak, Sailendra, author. | Uña, Gerardo, author. | Tourpe, Herve, author. | International Monetary Fund, publisher.
Title: Digital solutions guidelines for public financial management / Lorena Rivero del Paso, Sailendra Pattanayak, Gerardo Uña, and Herve Tourpe.
Other titles: Technical notes and manuals.
Description: Washington, DC : International Monetary Fund, 2023. | IMF Technical Notes and Manuals 2023/07. |Includes bibliographical references.
Identifiers: ISBN:
9798400251566 (paper)
9798400251665 (ePub)
9798400251634 (web PDF)
Subjects: LCSH: Finance, Public–Management. | Finance, Public—Technological innovations.
Classification: LCC HJ9733.R5 2023

Recommended citation:
Rivero del Paso, Lorena, Sailendra Pattanayak, Gerardo Uña, and Herve Tourpe. 2023. "Digital Solutions Guidlines for Public Financial Management." IMF Technical Notes and Manuals 2023/07. International Monetary Fund, Washington, DC.

Please send orders to:
International Monetary Fund, Publication Services
PO Box 92780, Washington, DC 20090, USA
Tel: (202) 623–7430 | Fax: (202) 623–7201
publications@IMF.org
elibary.IMF.org
bookstore.IMF.org

Contents

Abbreviations

AI	artificial intelligence
API	application programming interface
COTS	commercial-off-the-shelf software
DiGIT	Digital Solutions Guidelines Implementation Tool
DPI	digital public infrastructure
FMIS	financial management information system
IT	information technology
PFM	public financial management

I. Introduction[1]

Digital transformation of public financial management (PFM) can bring significant benefits to governments. First, it can enhance fiscal operations and ensure optimal use of public funds through process automation, which can reduce manual errors and increase the efficiency of financial transactions. It can also support budget planning and resource allocation as well as strengthen expenditure control and monitoring. In addition, digital solutions enable better monitoring and analysis of critical macro-fiscal policy objectives—such as revenue generation, expenditure patterns, cash flows, and debt levels—by providing real-time and accurate financial data, which can also promote fiscal transparency, budget credibility, and accountability. Digital solutions can also facilitate timely and comprehensive identification, assessment, and mitigation of fiscal risks including contingent liabilities, enhancing the government's ability to manage and respond to fiscal vulnerabilities effectively. All this, in turn, assists policymakers in making informed decisions in a timely manner on key fiscal and PFM issues.

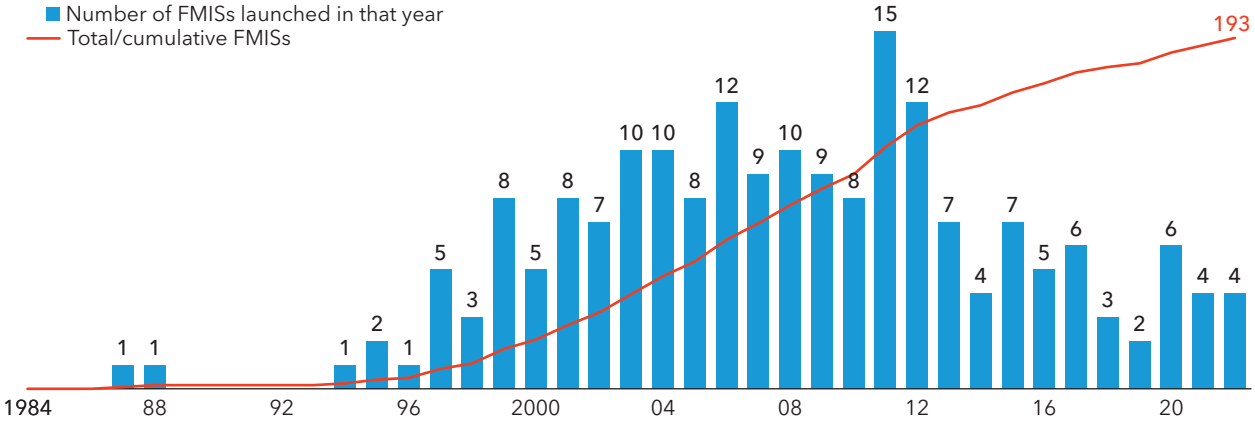
Governments have been using financial management information systems (FMISs) as the main digital solution to support their PFM functions. FMISs can be defined as a set of digital solutions to automate PFM processes including budget formulation, execution, accounting and reporting, as well as the custodianship and reporting of revenues (World Bank 2023). At their core, these systems provide a complete record of a government's financial events and transactions. They serve to generate and report fiscal data in a timely, relevant, and reliable manner, supporting decision making and control, and enabling accountability. When an FMIS integrates or interoperates with other government information technology (IT) systems that provide extended PFM functions—such as payroll, debt management, and e-procurement—it is generally known as an integrated FMIS.

The evolution of FMIS and its adoption by the ministries of finance can be traced back to the early 1960s, when the use of mainframe computers became increasingly common, and governments began to recognize their potential to automate financial processes. The first FMISs were standalone systems, used primarily by finance and accounting departments to track expenditure, manage accounts payable and receivable, and generate financial statements. In the 1980s and 1990s, the use of personal computers and local area networks became widespread, leading to the development of more comprehensive FMISs that could automate complex financial processes and were integrated with other government IT systems. Client-server architecture allowed multiple users to access the systems simultaneously, improving efficiency and data quality, and graphical user interfaces made these systems easier to use. In the late 1990s, the explosion of the internet led to the development of web-based FMISs, accessible from anywhere with an internet connection. According to the 2022 GovTech Dataset covering 198 countries, more than 190 FMISs have been launched around the world during the period 1984 to 2022 (Figure 1).

As FMIS capabilities have evolved over time (Gray 1998), they can now be sophisticated systems that integrate government budgeting, accounting, financial reporting, and core financial management functions with other government IT systems, such as procurement and payroll management systems. The 2022

[1] This technical note has benefited from contributions from Raquel Ferreira, Mauro Fridman, Soren Langhoff, Ramon Narvaez, Soheib Nunhuck, Anupam Raj, Mark Silins, and Frankosiligi Solomon. The work is also informed by an initial working group, with the participation of Richard Allen, Felipe Bardella, Arturo Navarro, Ashni Singh, and Alok Verma. The work also benefited from valuable contributions for the piloting phase from Arvinder Bharath, Chloe Cho, Marcelo Lopez Cremona, Moulay El Omari, Noel Gallardo, and other previously mentioned contributors. The authors are also grateful for the support from Manal Fouad and Cigdem Aslan, and the contributions from the members of governments, civil society organizations, and international organizations, who have offered their valuable time, expertise, and insight during the piloting process, as recognized in Annex 1.

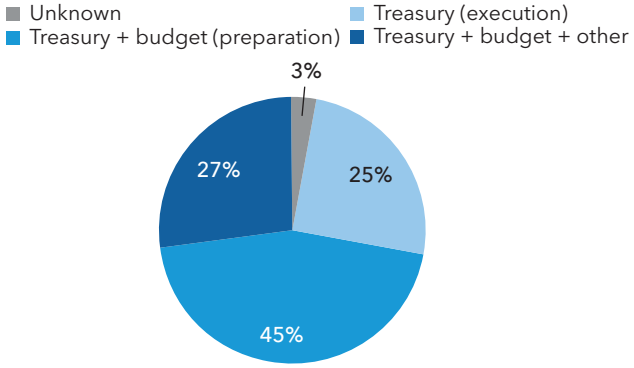
Figure 1. Launch of FMISs, 1984–2022



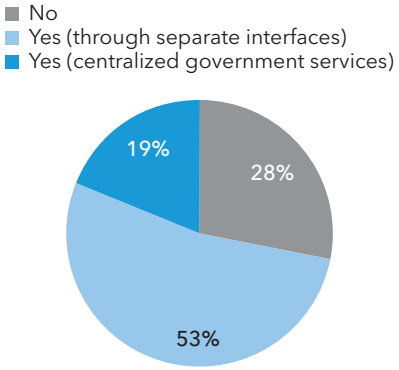
Source: World Bank GovTech Dataset (World Bank 2022).
Note: FMIS = financial management information system.

Figure 2. FMIS Functional and Data Exchange Capabilities

1. FMIS Functional Capabilities



2. Does FMIS Exchange Data with Other Systems?



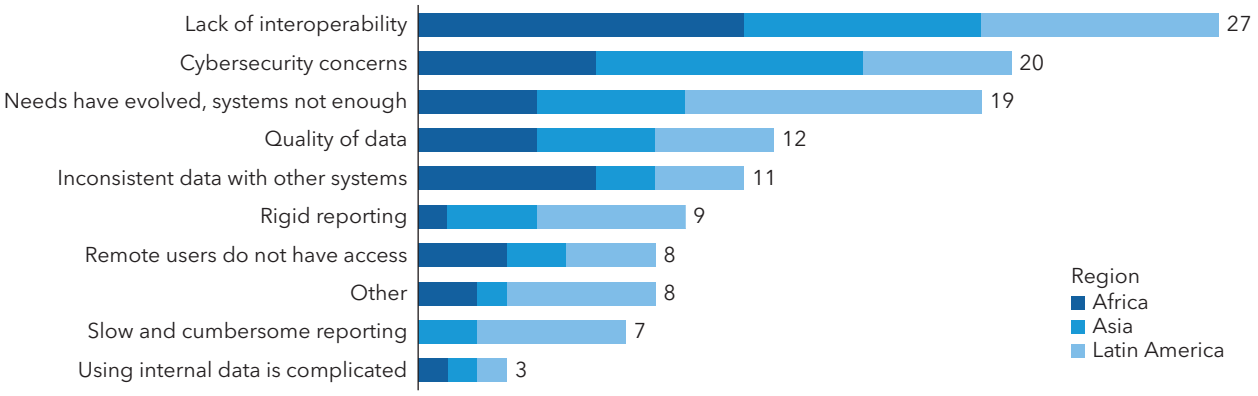
Source: World Bank GovTech Dataset (World Bank 2022).
Note: FMIS = financial management information system.

GovTech Dataset shows that in more than 140 countries, these systems support more than just budget execution and treasury management and allow exchange of data with other systems (Figure 2).

However, despite large investments from governments and development partners over more than three decades, many countries still face challenges in transforming FMISs into effective tools of fiscal management. The literature provides many reasons for FMIS underperformance, including absence of a well-prepared conceptual design, lack of ownership, weak project management, inadequate definition of new functionalities, adoption of inappropriate technology, and vendor lock-in (Diamond and Kehmani 2005; Dener, Watkins, and Dorotinsky 2011; Uña, Allen, and Botton 2019). Furthermore, a recent survey of 30 countries across different regions and income groups showed that lack of interoperability, cybersecurity concerns, and evolving needs of governments remain a significant challenge for IT systems that support PFM functions (Figure 3).

The aforementioned challenges, coupled with weak institutional and human capacity in several countries, hinder governments from reaping the full benefits of digital innovations and disruptive technologies to improve PFM. While ministry of finance officials may express interest in the adoption of new

Figure 3. Main Issues or Challenges Faced by PFM IT Systems in 30 Countries, by Region



Source: Authors based on surveys conducted before the workshops to pilot these Guidelines (see Annex 1).
Note: IT = information technology; PFM = public financial management.

digital innovations—such as the new generative artificial intelligence (AI)—the lack of foundational elements may undermine the possibility of such adoption. Deficiencies in data governance practices can also limit the possibility of getting more value from the data already collected. Furthermore, while adopting digital innovations in PFM, governments must comprehend the multidimensional nature of digital risks, including cyberattacks and threats, digital fraud and data privacy, as well as risks arising from human errors, digital divide concerns, and reputational risks. When selecting digital solutions, it is essential to systematically consider risk mitigation measures across the three layers involved in handling data: people (for example, internal and external users of digital solutions or systems, including government staff and citizens), technology (from IT infrastructure to applications), and PFM business processes; this is also important to avoid reputational risks and financial waste (Amaglobeli and others, 2023).

Digital solutions, which refer to a much wider range of digital tools and systems than FMISs,[2] can have a transformational effect on a PFM function, process, and/or output, as illustrated in Figure 4. Such an effect typically increases as adoption of digital solutions progresses through three stages: (1) simple replication of a manual process in a digital form (for example, change in which a signature on paper is no longer required and replaced by user authentication), usually known a "digitization"; (2) cases in which a process is digital by default, with all of its major steps automated (for example, complete replica of a business process in which invoices are submitted online with no manual intervention), known as "digitalization"; and (3) state in which a process is digital by design and thus reengineered and optimized to take advantage of available digital solutions, known as "digital transformation."[3]

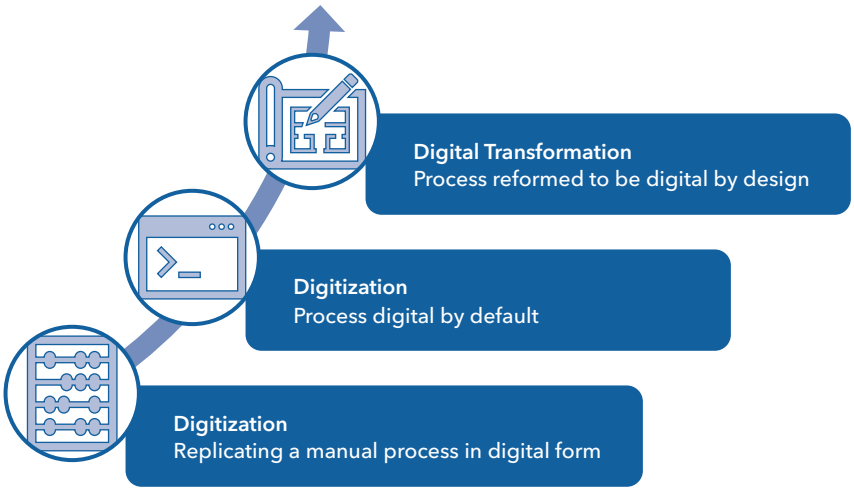
Governments have adopted digital innovations at different paces, reflecting not only barriers to digital transformation but also their specific windows of opportunity for such reform. Reengineering a process to be digital by design allows eliminating obsolete practices, taking advantage of modern technologies[4] and building on the learnings of digital PFM pioneers. Countries with relatively basic infrastructure may be able to establish the foundations and leapfrog directly to digital transformation, even by using disruptive

2 AlphaBeta 2018.

3 Although the phrases "digital by default" and "digital by design" can refer to slightly different concepts in different contexts, they retain their literal meanings in this note. Business processes are "digital by default" when digital technologies are integrated as the default or primary methods to execute those processes, eliminating the need for manual intervention. They are "digital by design" when digital technologies are systematically and proactively incorporated into the design or structure of those processes to foster innovation and transformation.

4 Particularly in cases where legacy systems are already in place.

Figure 4. Stages of Adoption of Digital Tools and Solutions



Source: Authors.

technologies.[5] Reforms for digital transformation of PFM thus require careful design and adequate safeguards that are based on a clear understanding of the country's underlying infrastructure and needs, as well as its institutional strengths and weaknesses. Governments can also tap opportunities where digital solutions can yield rapid and substantial benefits, for example, using fiscal data to improve economic predictions (Misch and others 2017) and integrating digitalization of payments with a country's PFM system (Cangiano, Gelb, and Goodwin-Groen 2019), including fintech solutions (Uña and others 2023) for savings and a wider reach.

A country's progress in modernizing its PFM functions and IT systems may not necessarily follow parallel tracks. It is possible, for example, to have an IT system with broad coverage but with dysfunctional PFM processes, or vice versa. Although they are likely to be correlated, it is also not guaranteed that the efficiency of PFM and level of digital adoption in a country will be aligned with the quality of its public institutions. Governments can benefit from adopting digital solutions, but lack of appropriate safeguards may also exacerbate preexisting corruption risks, particularly in countries with weak institutional capacity and poor governance. Therefore, governments should seek to make improvements in all relevant areas—efficient PFM functions, modern digital solutions, and sound governance and institutions—and approach the adoption of digital solutions in key PFM functions holistically, from the functional, technological, and governance and management perspectives. This Technical Note sets out the general framework of Digital Solutions Guidelines for Public Financial Management (hereinafter called "guidelines") to assist governments and other relevant actors in this endeavor.[6]

[5] For example, Gupta and others (2017) noted that Estonia skipped over several stages and now operates in a fully digitalized environment, using blockchain-distributed ledger technology and a "data embassy" that can reboot in the event of a cyberattack.

[6] The guidelines are part of the IMF's Digital Revolutions in Public Finance project, which has already made important contributions to the knowledge of digital transformation in fiscal policy. This project has been supported through the Digital Revolutions grant of the Bill & Melinda Gates Foundation.

II. Objectives and Users of the Guidelines

The Guidelines aim to facilitate digital transformation of key PFM functions by (1) providing a basis to assess existing PFM digital solutions and the associated governance and management practices, to identify strengths and weaknesses; (2) assisting with the design of digital transformation strategies; and (3) supporting the development of detailed functional requirements for introducing or updating PFM IT systems with robust building blocks that enable innovation with a purpose-oriented approach. This assess-design-improve approach to using the Guidelines (Figure 5) is further elaborated in section IV.

Figure 5. Uses of the Guidelines

Source: Authors.
Note: IT = information technology.

These guidelines, which emphasize the centrality of data throughout its life cycle[7] as the backbone of digital transformation of PFM, include the general framework with pillars, principles, and attributes (as discussed in this Technical Note and Manual), and are supplemented by (1) a forthcoming handbook with detailed descriptions of all principles and attributes, as well as examples on the application of the functional pillar across 11 key PFM functions (Table 1), which are further disaggregated into subfunctions based on system modules or processes[8] (Annex 3); and (2) the Digital Solutions Guidelines Implementation Tool (DiGIT).[9] The DiGIT, together with the handbook, aims to facilitate practical application of the guidelines, thereby supporting the development of reform roadmaps, policies, and action plans in specific country contexts.

7 Data creation, storage, usage, archival, and destruction.

8 While subfunctions and processes are distinct concepts, there can be overlaps as some outputs in PFM functions may entail single or multiple processes. The exact relationship between subfunctions and processes varies depending on the specific function of PFM.

9 DiGIT is a downloadable template that facilitates a comprehensive assessment of PFM digital solutions based on the general framework presented in this note and the detailed definitions presented in the handbook. The tool is available as a macro-enabled Excel worksheet and additionally as an OpenDocument spreadsheet.

Table 1. PFM Functions in the Handbook of the Guidelines

PFM Function
Fiscal forecasting and budget preparation
Budget execution and control
Treasury and cash management
Debt management operations
Accounting and financial reporting
Public investment management
Performance orientation of the budget and improved service delivery
Collection of tax and nontax revenues
Fiscal risks management and disclosure
Dissemination of fiscal information and PFM outcomes
Internal audit

Source: Authors, based on Allen and others 2015.

Note: Additional functions, such as public procurement and payroll, are also considered for the purpose of interoperability and automation of controls. PFM = public financial management.

Expected Audience and Users of the Guidelines

The key users of these guidelines include policymakers and senior managers at ministries of finance, such as budget, treasury, accounting, and IT directors, who could apply the general framework set out to ensure that opportunities are seized where appropriate to improve the design and outcomes of fiscal policy through digital solutions. Officials who have operational responsibility for the design and implementation of PFM processes[10] will find the guidelines—including the detailed maturity tables (Annexes 3–5), the granular Functional Attributes of PFM functions included in the handbook, and the DiGIT—useful for developing a strategy and roadmap for digital transformation of PFM. The guidelines will also be useful for development partners who support progress in FMISs or seek to improve PFM processes using digital tools. The private sector, including startups and software vendors who develop or strategize digital solutions for PFM, and several civil society organizations (for example, those working in CivicTech, public finance, and open government) would also benefit from being acquainted with the guidelines (Figure 6).

Methodological Underpinnings of the Guidelines

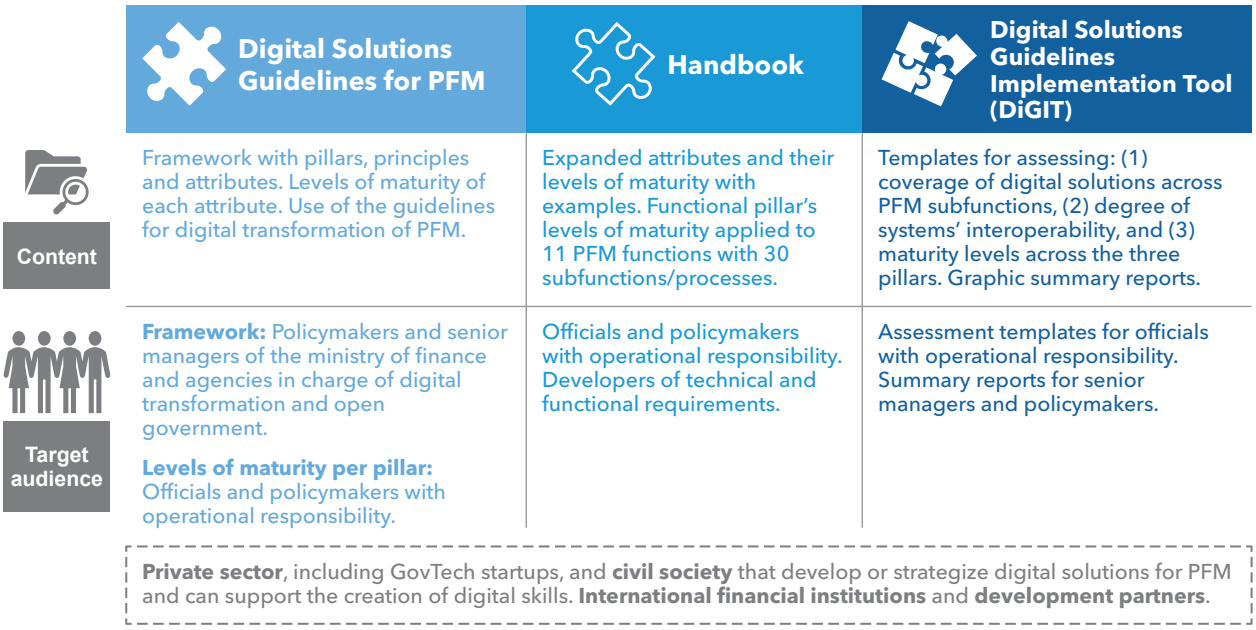
The guidelines are built upon four underlying precepts—purpose orientation, user-centricity, data-centricity, and iterative approach (see Box 1).

The guidelines are informed by a combination of expert knowledge, country cases, international standards, and good practices in the PFM area, relevant academic literature, and an extensive consultation and piloting process; Annex 1 further describes the consultation and piloting process.[11] This helped consider different perspectives, define the scope and approach, obtain feedback, and test the use of the guidelines to make them applicable to economies in different regions and in different stages of digital development.

[10] This includes officials within and outside of the ministry of finance as the digital PFM framework covers line ministries and spending agencies, public procurement offices, and government IT departments, among others.

[11] This consultation and piloting process included a series of workshops and meetings with various stakeholders including ministries of finance, international financial institutions, development partners, and civil society organizations.

Figure 6. Target Audience and Users of the Guidelines



Source: Authors.
Note: PFM = public finance management.

BOX 1. Underlying Precepts of the Guidelines

1. **Purpose orientation:** By focusing on the different public financial management (PFM) functions, they seek to emphasize the importance of a purpose-oriented digital reform. Recognizing that technology evolves, and different solutions can be adopted to support specific PFM processes, the guidelines do not endorse the adoption of specific digital solutions, technology, or applications. They do recommend core principles that PFM digital solutions should observe from a practitioner's perspective.
2. **User-centricity:** The development of these Guidelines has benefited from defining very early on that the target audience is practitioners and implementers of PFM digital solutions, from the policy, management, or development point of view.[1] They help create a bridge of understanding between the functional and information technology areas, making digital transformation and the adoption of digital innovations more attainable.
3. **Data-centricity:** The pillars, principles, attributes, and levels of maturity of the framework recognize data as the backbone of digital transformation of PFM. The data used for decision making will only be as good as their quality, coverage, and timeliness. Transparency and accountability are also affected by how the data are collected and made available to the public.
4. **Iterative approach:** The framework presented in this Technical Note has already undergone several iterations, which have benefited from the consultations, pilots, and workshops. However, considering that technology and processes continue to evolve, these Guidelines could be further iterated in the future. The Guidelines could also be expanded to cover additional PFM functions, such as financial transactions with subnational governments, payroll, procurement, or external audit, among others.

Source: Authors.
Note: PFM = public financial management.
[1] Furthermore, the development of these guidelines has been led by the IMF's Fiscal Affairs Department staff who have previously held positions in ministries of finance and have developed and administered different PFM systems.

The analytical approach to development of the guidelines included four main steps: (1) identification of the main PFM functions and processes supported by IT systems; (2) assessment of the requirements for these functions and processes in line with PFM diagnostic frameworks such as the IMF's Fiscal Transparency Code and Public Investment Management Assessment, as well as Public Expenditure and Financial Accountability; (3) benchmarking against good practices to identify the main technological aspects in digital solutions, including the Organisation for Economic Co-operation and Development's Digital Government Policy Framework (2021b); and (4) identification of high-level functional requirements for FMIS conceptual design, including work done by the World Bank (Hashim 2014; Hashim and Piatti 2016), the Inter-American Development Bank (Pimenta and Seco 2021), and others (Long and others 2023).

III. Framework and Structure of the Guidelines

The general framework of the Guidelines is built around a three-level structure (Figure 7):

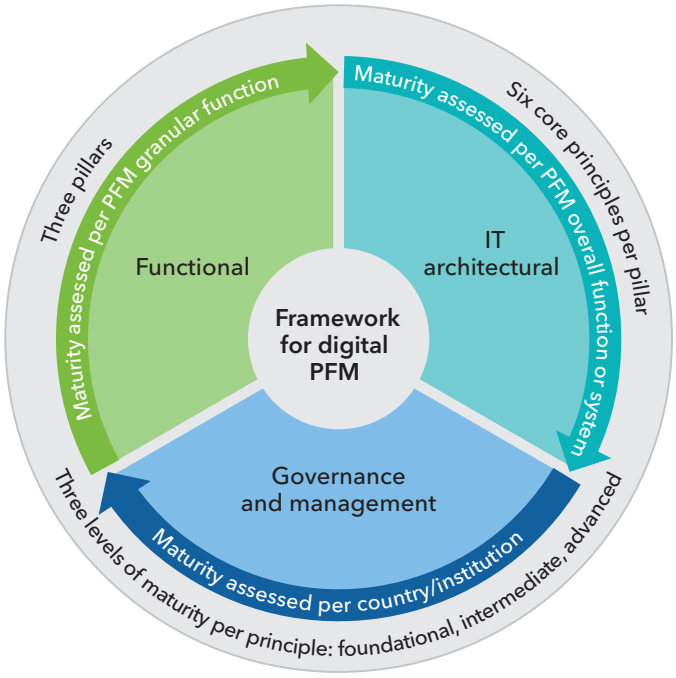
I. At the first level, the framework provides three pillars of digital solutions. While the underlying technology, scope, and functionalities of digital solutions for PFM can vary from country to country, they are founded on three pillars: (1) functional, referring to how digital solutions are used to support, automate, or redesign a business process; (2) IT architectural, denoting the features of the underlying technology, including cybersecurity considerations; and (3) governance and management, including the legal and institutional aspects that support or deter PFM processes for being digital by design. This is a construct that also reflects the traditional "people-process-technology" principle, which drives action. The three pillars of the framework can be used differently: the functional pillar can be applied to each PFM subfunction or process; the IT architectural pillar can be applied to each system or module; and the governance and management pillar can be applied government wide across the PFM IT systems and institutions.

II. At the second level, each pillar comprises six principles that usefully reflect the characteristics of the digital solution for fiscal operations.

III. At the third level, each principle is further broken down into one to four attributes, which provide additional specifications and granularity (Figure 8). Each principle and attribute is described in Tables 2–4.

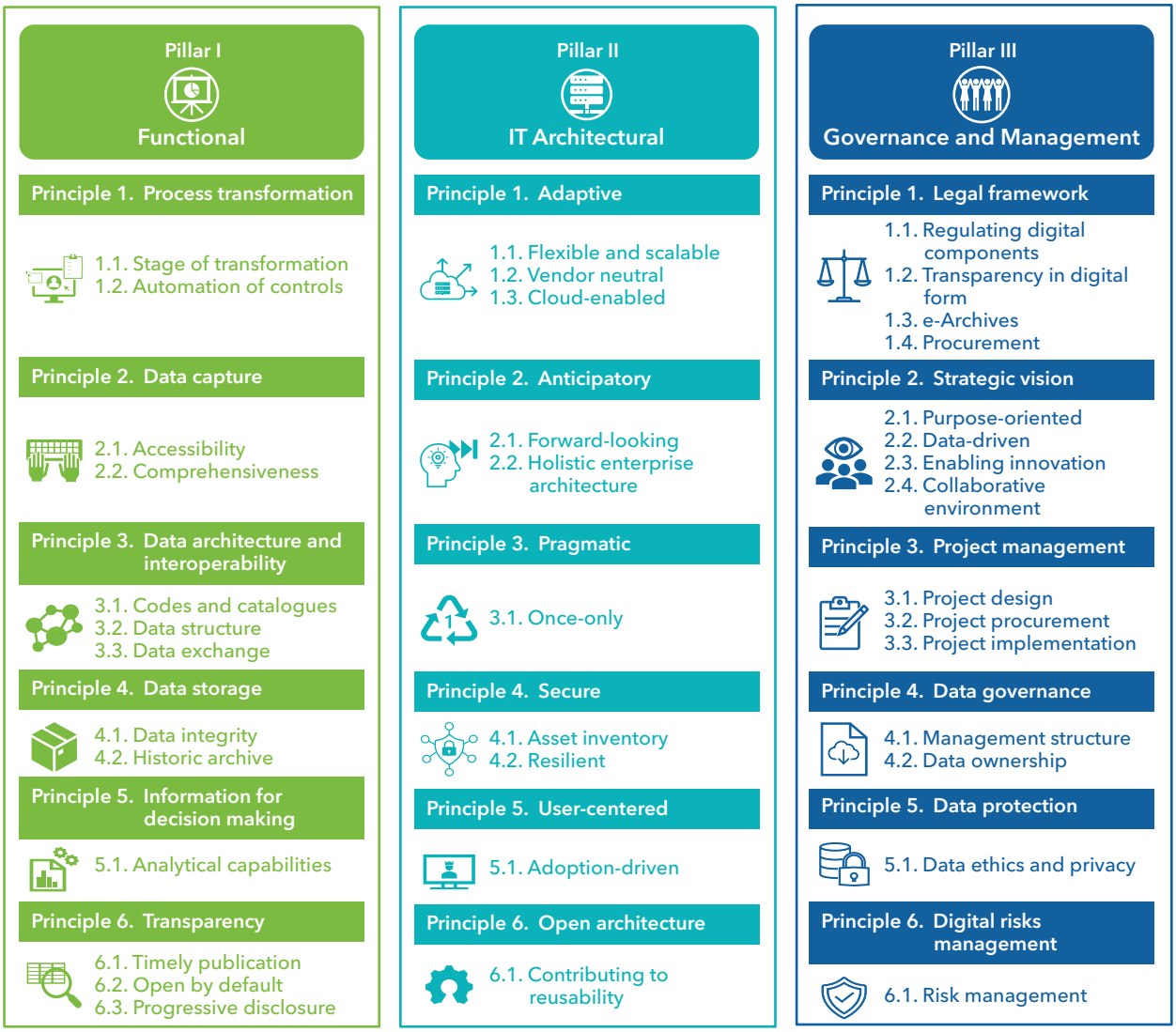
IV. Attributes are further described for three levels of maturity or progression, which allow assessing a system, an ecosystem of solutions, or institutional arrangements, according to each pillar (Annexes 3–5).

Figure 7. Framework for Digital Solutions in PFM



Source: Authors.
Note: IT = information technology; PFM = public financial management.

Figure 8. Principles and Attributes across the Three Pillars



Source: Authors.
Note: IT = information technology.

Table 2. Functional Principles and Attributes

Functional Principles and Attributes		
Process transformation	PFM digital solutions should streamline processes, eliminating unnecessary steps and reducing the need for manual intervention. They should automatically apply PFM business rules for control and compliance based on the legal framework, enhancing efficiency, effectiveness, and traceability, as well as aiding the detection of potential deviations from targets and financial mismanagement.	
	Stages of transformation	The system should support the automated execution of repeatable and sequential tasks based on business rules and user roles. The levels of automation will range from simple replication of a manual process in a digital form ("digitization") to processes that are digital by default ("digitalization") and processes which could be reengineered or optimized with available or new digital tools ("digital transformation").
	Automation of controls	The automation of control tasks should be optimized, supporting compliance with defined business rules, separation of duties, and data quality, and enable automated consistency checks and identification of anomalies, including through digital innovations.
Data capture	PFM IT systems should (1) support gathering and consolidating timely, comprehensive, and reliable data that are generated along the PFM cycle and/or required from specified outside sources to support PFM functions; and (2) enable automating data gathering and data consolidation across the general government.	
	Accessibility	The PFM IT system should be accessible through a network and allow, if needed, accessibility in low-connectivity settings that can adapt to emergencies and low-bandwidth situations. The systems should operate on the internet, as opposed to files in local computers or servers and not require on-premises presence (that is, secure authorized access from anywhere).
	Comprehensiveness	The system should enable gathering and consolidating required data to enable a comprehensive overview of the fiscal activities of the public sector and its subsectors (for example, central government) aligned with international standards.
Data architecture[1] and interoperability	The data architecture embedded in the PFM IT systems should be designed to allow agile and secure exchange of data internally and externally. The data architecture should avoid the development and growth of disconnected databases or siloed systems that have difficulties for interoperability with other PFM functions or systems. Interoperability should be maintained through a clear and effective data governance program—including shared taxonomy codes, catalogs, and classifications.	
	Codes and catalogs	The data architecture should incorporate the required classifications for financial flows and stocks based on the chart of accounts[2] and budget classification (including categorization needed for cross-cutting analyissi such as gender or green budgeting) and allow inclusion of expanded codes and catalogs to capture additional information needed by public agencies and standard taxonomy to enable interoperability. These catalogs should be kept updated and consistent among different modules and systems.
	Data structure	The data should be captured and stored in a structured format to enable and facilitate its use for required automation, controls, and analyses from the business processes perspective. The use of nonstructured data (for example, files such as images or PDFs) should be minimized, and when unavoidable, it should include the metadata to identify its content.
	Data exchange	The systems should include the relevant taxonomy and connecting identifiers to allow connectivity and information sharing among them. The exchange can be among PFM IT systems, auxiliary PFM systems, or other databases necessary for analysis.

(Continued)

Table 2. Functional Principles and Attributes *(continued)*

Functional Principles and Attributes		
Data storage	PFM IT systems should allow data to be readily available for historical analysis, transparency, and oversight, while ensuring data integrity.	
	Data integrity	The system should ensure the reliability and trustworthiness of the stored data. Data collection and storage should allow saving every change as a new data point and should not allow overwriting. Every change should have a timestamp and log of the users making and validating the change.
	Historic archive	The data should be preserved digitally for historic analyses in compliance with data preservation norms according to related legislation, whenever available. The system should have the capacity to store large amounts of data without overwriting registries in the database.
Information for decision making	PFM IT systems should provide information that is useful for decision making under the different roles of the organization, including technical day-to-day operations, managerial decision making, and oversight roles such as auditing.	
	Analytical capabilities	The system should allow for real-time reporting and analytics, particularly for data with high update frequency. The system should generate automated analytic reports based on the needs of the different organizational roles and users of the system, and support decision making through automated analysis and alerts. These capabilities can be enhanced through advanced data analytics techniques such as machine learning and predictive models.
Transparency	The PFM IT systems should support a user-centered transparency of the PFM processes, decisions, and outputs, including by enabling the publication of clear, reliable, frequent, timely, relevant, comprehensive, and accessible open data.	
	Timely publication	The system should support the publication of PFM reports, according to PFM legal framework, and data in a timely manner, including real-time publication and insights.
	Open by default	The data contained in the systems should be proactively classified as public data, open by default, unless it compromises security or personal data privacy.[4]
	Progressive disclosure[3]	Publication should be sequenced and tailored by considering the user experience and the diverse needs and levels of expertise of different groups of audiences.

Source: Authors.

Note: IT = information technology; PFM = public financial management.

[1] Data architecture defines information flows in an organization and how they are controlled, including the models, policies, rules, or standards that govern which data is collected, arranged, integrated, and put to use in data systems and in organizations.

[2] See Cooper and Pattanayak (2011).

[3] That is, an interaction design pattern that sequences information and actions across several screens (for example, a step-by-step signup flow). The purpose is to lower the chances that users will feel overwhelmed by what they encounter. By disclosing information progressively, interaction designers reveal only the essentials and help users manage the complexity of feature-rich websites or applications (see Gracida and Rivero del Paso, 2019).

[4] Global Initiative for Fiscal Transparency, Ministry of Finance, and Public Credit of Mexico 2018.

Table 3. IT Architectural Principles and Attributes

IT Architectural Principles and Attributes		
Adaptive	The IT strategy should account for the ever-changing nature of technology, business needs, trends, and emerging risks.	
	Flexible and scalable	To facilitate the adoption of new technologies, the systems should avoid monolithic architecture for an architecture characterized by flexibility and scalability that is often based on modular and reusable components, which can be easily integrated or replaced as needed.[1] In addition, adaptable architecture should include automated provisioning, monitoring, and self-healing to ensure that the system remains stable and reliable, even as it changes over time.
	Vendor neutral	Priority should be given to systems and platforms that can be seamlessly integrated with existing and future systems and allow the government to make changes without vendor-specific restrictions. This approach promotes an efficient digital ecosystem, preventing dependence on a single vendor, and the use of a combination of solutions that best meet government requirements.
	Cloud-enabled	The digital solutions should allow reaping the benefits of cloud services, including the ability to scale up or down as needed and access services that may not be available on premises,[2] flexibility in terms of location and device accessibility, and enhanced disaster recovery capabilities.
Anticipatory	Implementation and modernization of PFM systems should be designed in a forward-looking manner, prioritizing adoption of new technologies before converting legacy systems. This should be accompanied by a cost-effectiveness and sustainability analysis.	
	Forward-looking	Solutions should be selected based on their ability to integrate innovative and forward-looking technologies,[3] continuously identifying components nearing obsolescence.
	Holistic enterprise architecture	The digital solutions should be strongly aligned with the business trends and strategies, adopting an agile and continuous improvement culture.
Pragmatic	The collection of data should be comprehensive and granular at one entry point, avoiding duplication that could result in redundancies or inconsistencies, with a solid data architecture that promotes data accessibility, usability, reliability, and security.	
	Once-only	Data should be collected only once and reused or exchanged between different agencies as needed. While ensuring a single and dependable source of truth, it should also be possible to have multiple data repositories or replicate data for purposes such as disaster recovery or improved performance.
Secure	PFM IT systems should be designed to meet security and privacy requirements. Embedded security and data privacy controls should guarantee that solutions and processed data, in transit or stored, are adequately protected and reliable. Ultimately, the systems, processes, and practices should be resilient to adapt to the evolving cyberthreat landscape.	
	Asset inventory	Digital assets should be identified, classified, tracked, and protected (end to end) commensurate with their sensitivity and criticality, or dependency and interdependency with other digital assets.
	Resilient	Systems, processes, and practices should be designed and implemented with capabilities to manage threats and should be able to automatically activate fail-over capabilities to withstand or recover after a disruption.

(Continued)

Table 3. IT Architectural Principles and Attributes *(continued)*

IT Architectural Principles and Attributes		
User-centered		Digital solutions should be intuitive to use and adapted to the needs and roles of different users. Access to models and modes, including multichannel use, should provide flexibility for data analysis, ensure traceability and allow auditing, generate automated reporting, provide advanced data analytics, and allow raw data export.
	Adoption-driven	The design and deployment of digital solutions should aim for maximum adoption, while requiring minimum training. The key elements of this approach include conducting user research, applying user-centric design principles, ensuring clear and intuitive navigation, providing customization options, designing for responsiveness and adaptability, offering contextual help and documentation, and incorporating continuous user feedback.
Open architecture		The digital solutions architecture should maximize the reusability of components, as well as data, between public institutions and other relevant stakeholders.
	Contributing to Reusability	The government should optimize its investments in technology by systematically sharing reusable software components across systems[4] and, when possible, making them available as digital public goods.[5] The data disseminated should be open and aligned with digital data standards[6] when available, enabling external reusability.

Source: Authors.

Note: IT = information technology; PFM = public financial management.

[1] The architecture could adopt a modular, microservices, or serverless approach. A discussion about a modular approach of financial management information systems is presented in Uña, Allen, and Botton (2019).

[2] Such as artificial intelligence computing, software as a service.

[3] Examples include systems that natively expose their functions through an application programming interface, or adapt interfaces based on the user device (for example, a computer or smartphone).

[4] Such as identification and authentication tools, information mediators, security features, consent management systems, and more. For a reference list of digital building blocks, the GovStack Initiative has compiled a list and is developing technical specifications that can be accessed in their website (GovStack n.d. b).

[5] According to the Digital Public Goods Alliance, "digital public goods are open-source software, open data, open AI models, open standards, and open content that adhere to privacy and other applicable laws and best practices, do no harm by design, and help attain the Sustainable Development Goals (SDGs)." The definition encompasses (1) open software, (2) open data, (3) open artificial intelligence models; (4) open standards, and (5) open content (https://digitalpublicgoods.net/digital-public-goods/).

[6] Such as internationally recognized open data standards.

Table 4. Governance and Management Principles and Attributes

Governance and Management Principles and Attributes		
Legal framework	The legal and regulatory frameworks should support the modernization of PFM functions with digital tools. Where necessary, laws and regulations should be amended to be more flexible and agile to promote digital innovation, transparency, and interoperability.[1]	
	Regulating digital components	Regulatory backing required to implement or update processes to be digital by design should be provided (for example, in fiscal responsibility, debt management or budget laws, digital government laws, or their secondary regulations), eliminating unnecessary or duplicative manual processes. In addition, regulated processes should support the operation of systems.
	Transparency in digital forms	The legal framework should promote PFM transparency and right to information in digital forms of data that enable the publication and reuse of primary source data in human and machine-readable formats (for example, norms for open data). In addition, legislation should specify required procedures, timeliness, and contents in line with the Fiscal Transparency Code of the IMF.
	e-Archives	The legal framework should define the norms and rules for data storage and preservation to support e-archiving, which will enable historical analyses and promote long-term accountability. Such regulation should underpin the data governance.
	Procurement	Traditional procurement laws and regulations should be assessed, and if necessary, updated and streamlined, as they may lack clarity (for example, in distinguishing digital products and services from other types of goods and services) and agility (for example, iterative and modular contracts) required for rapid digital transformation.
Strategic vision	The organizational culture should recognize the value of innovation and foster an enabling environment for comprehensive reforms.	
	Purpose-oriented	Digital projects should be designed to support national priorities and international obligations. The importance of purpose-driven approach should be widely recognized, with clear identification of problems that need to be addressed through a digital PFM project.
	Data-driven	There should be governmentwide emphasis on data-driven decisions,[2] based on high-quality and high-frequency fiscal data, to enhance service delivery and drive efficiencies in fiscal operations.
	Enabling innovation	To maximize the benefits of emerging technologies, the government leadership and institutional arrangements should provide an enabling environment for experimentation; collaboration with private sector, civil society, and academia; investment in research and development; and prioritization of the development of digital skills among government officials.
	Collaborative environment	Given that digital PFM reform requires effective collaboration at many levels, there should be clear structure and leadership to coordinate the efforts and build common infrastructure inside the government, moving away from the traditional silo-based approach.

(Continued)

Table 4. Governance and Management Principles and Attributes *(continued)*

Governance and Management Principles and Attributes		
Project management	There should be a well-designed plan and a well-functioning team to address any practical and operational issues during the design, procurement, and implementation stages along the PFM IT system project cycle.[3]	
	Project design	Digital PFM projects should have clear objectives, scope, functional requirements, technical specifications, performance metrics, timeline, budget, and specific legal or regulatory considerations. In addition, user experience, data security, interoperability, scalability, and maintenance requirements should be considered.
	Project procurement	The process of procurement should support agile project management by adopting iterative contracts. It should also include market research, clear definition of requirements, competitive bidding, calculation of the total cost of ownership, and robust contract management after the contract award.[4]
	Project Implementation	Project implementation should ensure a clear understanding of user needs; iterative and agile development, including early prioritization and testing; regular stakeholder engagement; effective communication; and monitoring for continuous improvement.
Data governance	Policies, procedures, and mechanisms should ensure the proper management and quality of data throughout its life cycle, which are crucial for maintaining transparency, accountability and informed decision-making in PFM.	
	Management structure	The management structure for PFM IT systems should include a clear definition of roles and responsibilities, a set of policies and procedures for managing and exchanging data, and clear processes for monitoring and improving data quality, managing data risks, and reporting on data governance activities.
	Data ownership	The government's legal right and control over specific data should be clearly defined, including how the data will be collected, stored, accessed, used, shared, and disposed. The rights and responsibilities of the owner of data—including controlling access, determining handling practices, and making decisions about data usage, retention, and transfer—should also be established.
Data protection	Data collected should be handled responsibly, considering its ethical use and respect for privacy rights.[5]	
	Data ethics and privacy	Adoption of PFM digital solutions and innovations should factor in data confidentiality, integrity, and availability by implementing robust security measures, obtaining informed consent, adhering to data protection regulations, and respecting privacy rights while maintaining data anonymity and using data for legitimate purposes.
Digital risks management	The threats to digital solutions and related data, which can range from systems outage to data breach and other cybersecurity risks, should be recognized, controlled, and mitigated upfront.[6]	
	Risk management	A risk-management approach—both ex ante and ex post—should be embedded into digital PFM projects. During the project planning stage, risk management plans should be developed to identify all potential risks, adopt preventative measures, design mitigation actions and monitoring plans, and assign responsibilities and ownership.

(Continued)

Table 4. Governance and Management Principles and Attributes *(continued)*

Source: Authors.

Note: IT = information technology; PFM = public financial management.

[1] In some countries, some existing core legislations were amended to allow administrative procedures to be technology-independent or to enable digital communication and electronic signatures (for example, Sweden's Administrative Procedures Act and Austria's General Administrative Procedures Act). Countries that have amended their access to information legislation often have introduced a more comprehensive legal basis for digitalization or digital transformation of the public sector. For example, Estonia included several provisions on administration of databases (including roles and responsibilities for controllers), rules for use (only databases created by law and prohibition of duplicate data), principles for the system (open data and metadata to be machine readable, open format), establishing the legal basis for taxonomy, and classification to ensure interoperability. Other countries have adopted these provisions within broader legislative initiatives, such as the Open Government Data Act in the United States or eGovernment Act in Austria. For PFM-related legislation, more targeted amendments to PFM laws or accounting laws (for example, machine-processable invoices mandatory in invoicing with the public sector) and archives laws (for example, principles for collecting, evaluating, archiving, preserving, accessing archival documents) may be needed. Privacy laws may also need to be amended to protect the fundamental rights and freedoms of citizens with respect to the processing of their personal data. Another current debate on legal reform on the area is whether it is more advisable to develop a technology-neutral legal environment, meaning unless necessary, no legislation regarding any technology should be adopted (for example, artificial intelligence, distributed ledger technologies, big data, cloud computing, and Internet of Things).

[2] Organisation for Economic Co-operation and Development 2019.

[3] Fritz, Verhoeven, and Avenia 2017.

[4] For more details, see Hashim and Piatti (2018) and Open Contracting Partnership (2019).

[5] Organisation for Economic Co-operation and Development 2021a.

[6] While cybersecurity is addressed in the IT architectural pillar, the principle in the governance and management pillar covers the management component of it.

Levels of Maturity or Progression

To allow for a sequenced approach to development and implementation of PFM IT systems while taking country context and capacity into account, the Guidelines further disaggregate each attribute under each principle of the respective pillars into three levels of maturity or progression in the adoption of digital solutions: (1) foundational, (2) intermediate, and (3) advanced. The levels of maturity are sequential in nature, with the first level reflecting foundational or minimal elements that need to be considered in a sustainable adoption of digital solutions.[12] In some cases, a country could identify elements of a more advanced level in its systems, while not fulfilling the elements of the foundational level. In such cases, the progression should consider whether the proper foundations are also in place.[13]

The levels of progression of the functional and IT architectural pillars can be used to assess an existing PFM IT system or module. They can also be used as blueprint for countries designing new or updated PFM digital solutions. In this case, the country could identify the required actions to adopt the advanced-level elements, avoiding piecemeal progression. In case a technical requirement has been drafted, the authorities can use the levels of progression to identify gaps and opportunities to adopt better practices.

The governance and management pillar covers the overall ecosystem of the government's institutional arrangements. Considering that governmentwide arrangements effect the forms in which digital solutions are adopted, ministries of finance may find in this pillar some elements that are outside of their ambit. However, it is imperative to identify the systemic bottlenecks and accelerators that can be in place to reap the benefits of digital solutions in an efficient whole-of-government way.

Annexes 3 to 5 provide detailed descriptions of practices at each level—foundational, intermediate, and advanced—for all attributes, which could serve as the basis for practitioners' use of the guidelines. The functional attributes are further detailed in the handbook to reflect specificities of the processes and outputs related to each of the PFM subfunctions covered (Annex 2). A specific example of the functional attribute on "automation of controls," applied to the subfunction "government banking arrangements" under the "treasury management" function, is presented in Annex 6.

Relationships between Three Pillars of the Framework

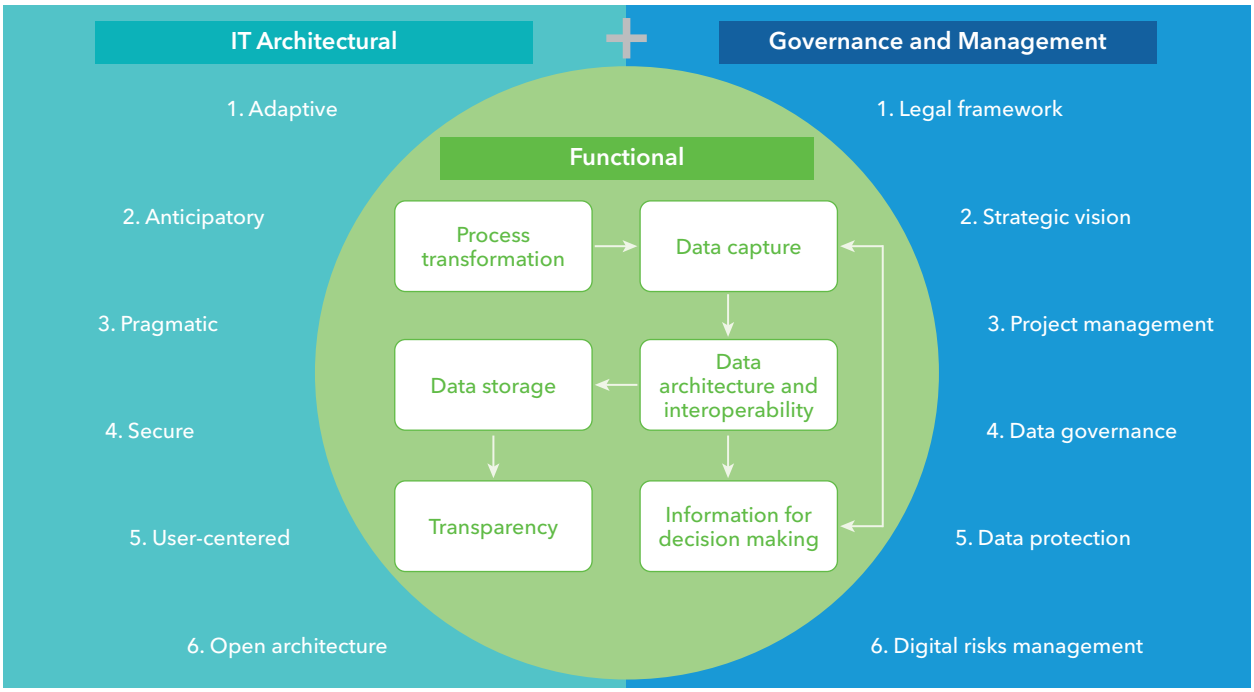
The three pillars of the framework are interconnected as in the "people-process-technology" construct. Figure 9 shows this interconnection among the functional, IT architectural, and governance and management pillars and their principles. The IT architectural and governance and management pillars are shown in the background, since they are key enablers to address any of the principles described under the functional pillar. As enablers, the six IT architectural and the six governance and management principles need to be considered for the development of any PFM IT project. By strengthening each of these principles during the assessment, development, and implementation of a PFM IT system project, the principles under the functional pillar become more attainable.

The functional principles are shown in the center sequentially, covering different aspects of the processes for generating, storing, and publishing data along the PFM cycle. Without capturing the data, it cannot be stored, and without having structured data in a database it is not possible—or it is extremely difficult—to

[12] Considering the different nature of the attributes, in a few cases the level of maturity does reflect what a basic adoption should consider, as opposed to the foundational requirements. This is specifically the case of the "flexible and scalable" attribute of the IT architectural pillar, which foresees a monolithic architecture in the first level.

[13] During the piloting phase, this situation came up often when analyzing the "transparency in digital forms" of the governance and management pillar. In this case, several countries are implementing digital tools for transparency, while not having foundations that would also cover access to information requests. This situation highlights the willingness of governments to share information, but it also emphasizes the critical role played by legal and institutional access to information frameworks. These frameworks are essential in enabling transparency for aspects that may not be legally mandated in official reports or proactively disseminated by the government.

Figure 9. Interrelation between the Three Pillars



Source: Authors.
Note: IT = information technology.

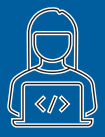
conduct meaningful analysis, generate fiscal reports, or disseminate the results on a website in a timely and consistent way. However, capturing data also requires not only the preconditions in the IT architectural and governance and management pillars but also support from the "data architecture and interoperability" principle of the functional pillar as well. The feedback loop allows the implementation of enhancements or upgrades to the systems. For example, Figure 9 shows interconnections between the "information transparency" and "data capture" principles. This continuous feedback loop allows users to detect gaps and implement improvements also in the underlying IT architecture supporting the system and/or the legal framework and regulations underpinning governance and management.

Some principles and attributes across all three pillars are also directly interrelated, highlighting the importance of developing digital solutions while considering all three angles. An example is "data architecture and interoperability"—a functional principle—which can be supported by a "pragmatic" system that is designed with "once-only" feature—an IT architectural principle—and a robust framework for "data governance" that enables data exchange—a governance and management principle. Similar interactions are found elsewhere, which are not always one-to-one. For example, the principle on "project management" is essential to carry out any IT project within a specific timeframe and budget. Professional project management also helps to achieve other governance and management attributes, such as having a purpose-oriented vision. As illustrated by these examples, different principles and attributes will constantly interact during the development and implementation of any PFM IT project. Figure 9 serves as a high-level representation of the main relationships.

In addition to the interactions within the framework, digital PFM projects should consider how each principle and attribute relates to the high-level architecture of a system (Table 5). Taking the functional principle on "data architecture and interoperability" again as an example, the data layer should provide

a structured way to store and access data after a common model and standards, while the services layer should enable different systems to communicate and interact with each other.[14] The solutions layer could further promote a unified user experience by providing a common platform for different systems. Each layer and their components can be acquired as commercial-off-the-shelf (COTS), as anything as a service,[15] or can be bespoke developments, either developed in-house or outsourced.

Table 5. High-Level Three-Tier Architecture of a System

Layer	Description
Data layer 	Data is the foundation of any information system, and as such its quality will enable or inhibit its use to control and streamline business processes or to support informed decision making. Ministries of finance have amassed data for decades; however, for data to be efficiently used it is necessary that its quality is ensured and monitored. Unreliable, difficult-to-extract, or siloed data hinders the potential of the vast data to support operational control and decision-making processes. Maintaining proper data quality requires establishing data governance practices as a general framework, including policies and procedures for managing the availability, usability, integrity, and security of the data.
Services layer 	The services layer is an architectural dimension that provides ready-to-use, optimized, and configurable functions that are common across many applications. This layer usually manages the business rules.[1] A service layer should be considered for interoperability and reusability. The development should consider identifying the components that could be used and benefit other PFM systems or even a wider applicability that could benefit from close collaboration across government agencies. The mindset of building blocks[2] would help foster a wider reusability of components.
Solutions layer 	The solutions layer relies on the foundations established under the data and services layers to provide capabilities more specific to PFM functions. Solutions include configurable platforms that can easily adapt to new business needs and future use cases. Increasingly, platforms take advantage of cloud capabilities, such as elasticity, user friendliness, strict use of standards, and evolvability. This progress is present in many types of platforms—for example, taxpayer portals, open data platforms, and payment and billing platforms. Solutions can be developed or benefit from reusing digital public goods that are open-sourced and licensed.

Source: Authors.

Note: While the three-tier architecture is a common example in PFM IT systems, it is important to note that various other architectural models exist to suit diverse application requirements and scenarios. PFM = public financial management.

[1] In some monolithic systems, the business rules have been programmed in the data layer, which makes managing changes in the business processes more complex.

[2] For more information on building blocks, consult GovStack (https://www.govstack.global/).

[14] Enterprise architects help develop and implement a modern infrastructure network and its data management requirements, business processes, digital services, and applications. Governments should take advantage of this progress and use their expertise to further strengthen its systems.

[15] Anything as a service encompasses a diverse range of products and tools available for purchase under an "as a service" consumption model. This is an evolution from the software as a service model.

IV. Using the Guidelines for Digital Transformation of PFM

Governments can achieve systematic and effective digital transformation of their PFM functions by using the Guidelines, based on the aforementioned "assess-design-improve" approach (Figure 5). This dynamic approach requires an iterative process through interconnected stages to facilitate continuous learning, adaptation, and improvement during the digital transformation journey. The intertwined nature of these stages ensures that the digital solutions remain effective throughout their lifecycle and accommodate new PFM requirements as a result of changing circumstances, emerging challenges, and evolving technology.

In "assess," the first stage, it is important to keep in mind that assessing the quality of a PFM IT system or digital solution often involves quantitative and qualitative evaluation, which can be influenced by perception. Insufficient evidence and a subjective assessment may result in a suboptimal strategy, exposing technical decisions to potential influence from stakeholders with political or other vested interests. The Guidelines provide a way of analyzing specific elements of a PFM digital ecosystem or individual IT systems to identify the strengths and weaknesses and develop a reform strategy (Box 2).[16] Such analysis can be done through DiGIT, a programmed spreadsheet-based implementation tool that helps understand the overall PFM digital landscape from multiple perspectives and assess the maturity of individual PFM IT systems based on the Guidelines (Box 3).[17]

BOX 2. Identifying the Strengths and Weaknesses of Public Financial Management Information Technology Systems

Generalized and top-down evaluation of systems are usually limited in their utility to plan next steps and make strategic decisions. By breaking down the analysis of systems into their specific elements and components, the guidelines allow identification of strengths, weaknesses, and next steps. The following examples highlight this for countries with different levels of digital adoption.

São Tomé and Príncipe: The review of the budget execution module, based on the draft guidelines, identified that although there are relevant challenges in using the existing system, the database structure that has linked the stages of expenditure transaction and accounting is sound and could allow additional parametrization of controls in the system to support better expenditure control.

The Philippines: In the context of an ongoing systems modernization process, the guidelines helped identify strengths and challenges, including strong aspects of current systems that should be considered in the updates. A review of digital solutions across different public financial management functions also helped identify areas where interoperability can be strengthened and options to do so.

"Design," the next stage, entails the development of a blueprint for the implementation of the digital PFM solution based on clearly identified objectives, including reengineering of PFM processes to make them digital by design, engaging stakeholders and mapping their roles and tasks in line with the reengineered processes, and evaluating technological alternatives to develop the digital PFM solution. During design

[16] The draft guidelines were used for IMF technical assistance in various countries. The experience showed that they allow a more objective and nuanced understanding of the issues and challenges faced in different country contexts and specific systems.

[17] DiGIT was developed based on the experiences from the testing and piloting phase, which highlighted the need for a practical tool that would allow systematic implementation of the Guidelines.

BOX 3. Digital Solutions Guidelines Implementation Tool

The Digital Solutions Guidelines Implementation Tool (DiGIT) is a tool designed for practical application of these Guidelines.[1] It includes 15 assessment sheets that allow for a comprehensive assessment of a country's public financial management (PFM) digital landscape, including (1) the coverage of digital solutions across PFM subfunctions, (2) the degree of system interoperability,[2] and (3) the level of maturity based on the three pillars. For the maturity level assessment, it provides detailed maturity tables similar or identical to those provided in Annexes 3 to 5. Functional attributes are detailed for all PFM subfunctions covered by the guidelines, as provided and explained in the handbook, while the IT architectural pillar can be applied to up to 11 systems or modules.

DiGIT offers a tailored, user-friendly experience and consolidates results in a visual, structured way. Users can customize the scope of their assessment according to their needs and choose not to complete all 15 worksheets. All worksheets include space for notes and provide drop-down lists of options to guide the assessment. The tool also comprises several result sheets which are autopopulate based on the assessment. The result sheets consolidate and visualize the results, providing a clear overview of the overall PFM digital ecosystem as well as the individual solutions (Box Figure 3.1). The interactive visualization can serve as a practical basis for country authorities, as well as support teams from development partners, helping them identify strengths and weaknesses of the current digital landscape to prioritize areas for reforms.

Source: Based on Cho and Rivero del Paso 2023.

1 DiGIT is available as either a Macro-Enabled Excel Worksheet or an OpenDocument Spreadsheet, following the emphasis put on open solutions by the Guidelines, with both versions allowing for easy movement within and across worksheets.

2 Interoperability check is completed based on the expected data exchange among subfunctions. The foundational, intermediate, and advanced practices for each subfunction, including which systems it should be interoperable with, are detailed in the handbook.

and implementation, practical challenges may arise, and feedback from stakeholders and users might reveal aspects that require improvement. These insights should inform the final stage, "improve," including through another iteration of assessment, if needed, and provide feedback into the design phase for fine-tuning and further enhancements of the digital PFM solution.

Developing a Strategic Plan for Modernizing PFM IT Systems

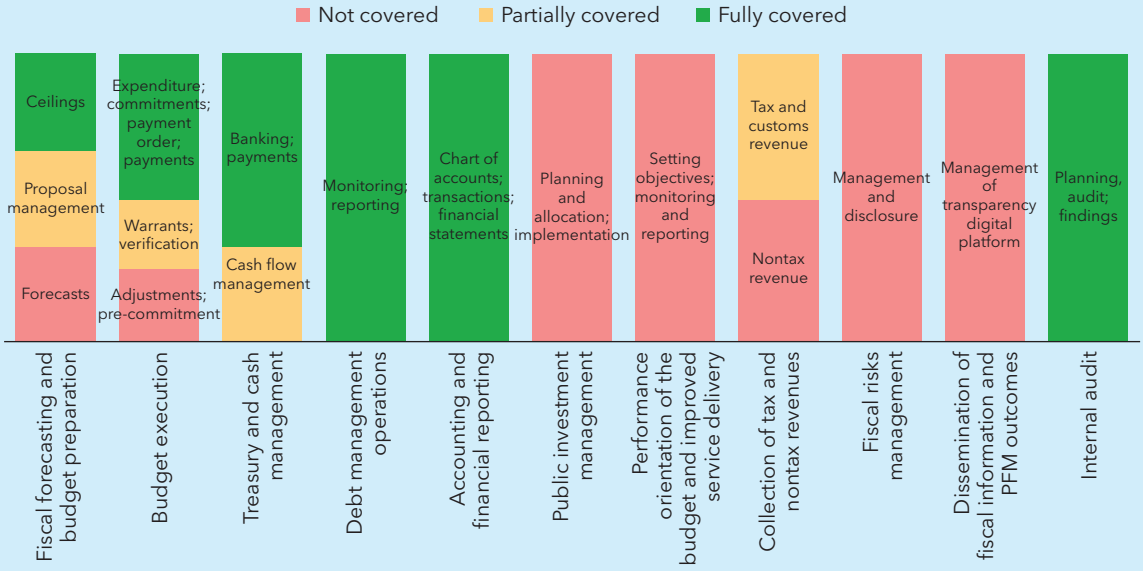
This section presents a set of steps and key elements to consider in sequencing PFM digital reforms, developing the related strategy, and choosing system development options, using the assess-design-improve approach. While these steps are discussed here from an analytical and conceptual point of view, practitioners should bear in mind that these steps can be intertwined as they consider an iterative approach. The ten key steps are as follows.

1. **Conducting assessment as a basis to prioritize and sequence:** Understand the current state of the organization's PFM digital ecosystem in terms of coverage, interoperability, and levels of maturity in functional, IT architectural, and governance and management aspects.
2. **Clearly identifying priorities and objectives:** This step should cover the following areas:
   a. Identifying key gaps in system coverage and maturity: Identify the problems and challenges to be addressed, along with their root causes. Consider the need for changes in PFM business processes, legislation, institutional arrangements, and technology (Figure 10).

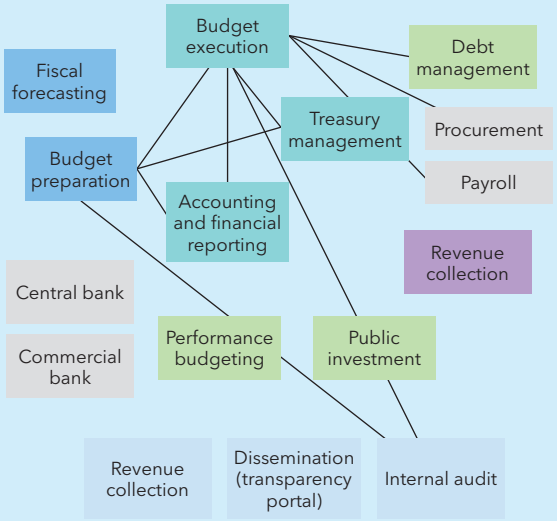
BOX 3. Digital Solutions Guidelines Implementation Tool *(continued)*

Box Figure 3.1. Sample Summary Reports from DiGIT

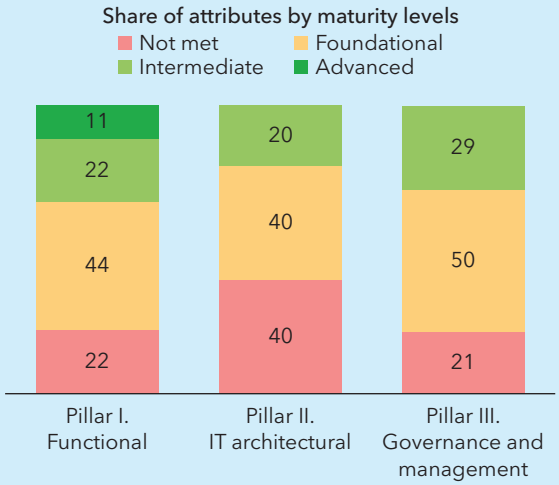
1. Functional Coverage



2. Interoperability Mapping



3. Overall Maturity for Three Pillars (Percent)



BOX 3. Digital Solutions Guidelines Implementation Tool *(continued)*

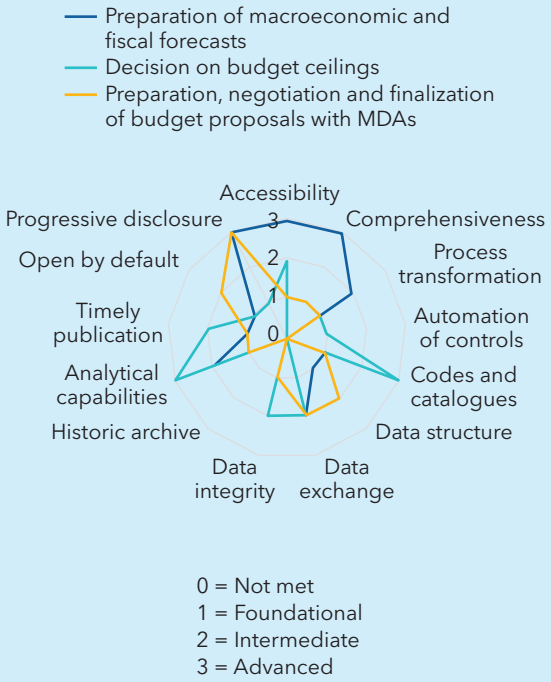
Box Figure 3.1. Sample Summary Reports from DiGIT *(continued)*

4. Maturity Level by Functional Attribute

Number of PFM functions assessed	1
Number of subfunctions assessed	3

Average functional maturity levels	
1. Data capture	
1.1. Accessibility	Intermediate
1.2. Comprehensiveness	Foundational+
2. Data processing and control	
2.1. Process transformation	Foundational+
2.2. Automation of controls	Foundational–
3. Data architecture and interoperability	
3.1. Codes and catalogues	Intermediate
3.2. Data structure	Foundational
3.3. Data exchange	Intermediate
4. Data storage	
4.1. Data integrity	Foundational
4.2. Historic archive	Not Met
5. Information for decision-making	
5.1. Analytical capabilities	Intermediate
6. Transparency	
6.1. Timely publication	Foundational+
6.2. Open by default	Foundational+
6.3. Progressive disclosure	Intermediate+

5. Detailed Maturity Level per PFM Function and Subfunction



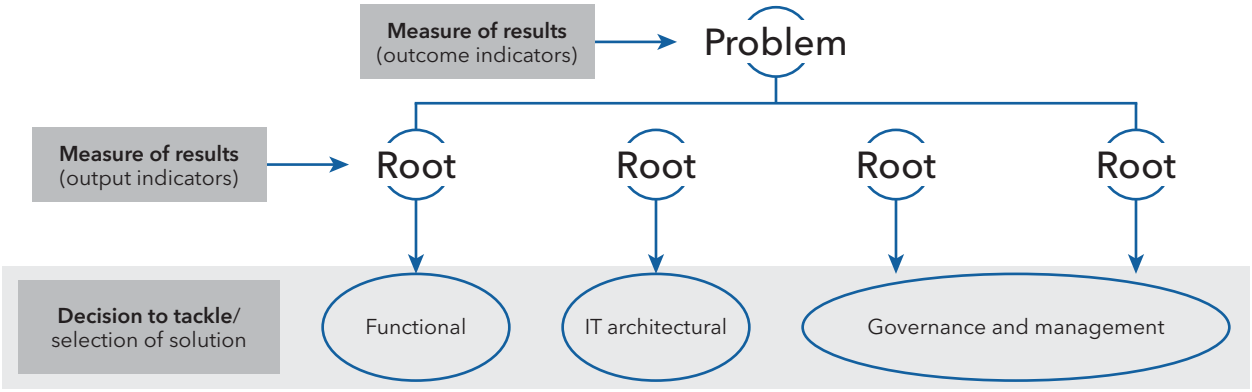
Source: Cho and Rivero del Paso 2023.
Note: IT = information technology; PFM = public financial management.

b. Balancing functional coverage versus deepening maturity of PFM IT systems: Balance the focus[18] on increasing the overall coverage of PFM functions through IT systems in relation to deepening the functional and IT architectural maturity of systems covering specific functions, subfunctions, or processes. The sequencing approach should be in line with (1) the overall PFM priorities, (2) the degree of risk implied by an existing solution,[19] and (3) the effect of a lack of digital solutions in supporting any given process.
c. Assessing feasibility: Prioritize process changes based on their potential effect and feasibility. Assess costs, required resources, and risks associated with implementing each change.

[18] Considering limited human and financial resources to design and implement digital solutions.

[19] Dependence on obsolete technologies exposes organizations to significant risks such as limited support and maintenance, compatibility challenges, decreased efficiency and productivity, increased costs, compliance and legal issues, and hindered innovation and competitiveness. Obsolete technologies may lack vendor support, may not integrate well with modern systems, may impede productivity, may be costly to maintain and support, may not comply with evolving regulations, may hinder the adoption of emerging technologies, and may hamper an organization's ability to innovate and remain competitive.

Figure 10. Example Identification of Root Problems for Digital Projects



Source: Authors.
Note: IT = information technology.

d. Developing vision statement and strategic objectives: Develop a vision statement that articulates the strategic objectives and expected scope of the reform. Clearly define benefits and improvements that digital solutions will bring to the organization and key stakeholders.

3. **Process mapping and streamlining to be digital by design:** Map out current business processes, identifying redundancies, unnecessary manual steps, and bottlenecks that can be eliminated or streamlined through digital solutions. Consider relevant laws, regulations, and compliance requirements and identify needs for reform. The levels of maturity of the attributes can be used to map good practices in the design and modernization of digital solutions (Box 4).
4. **Defining stakeholder involvement:** Identify key stakeholders and clearly define their respective roles and responsibilities. Establish technical working groups composed of functional, IT, and legal departments to provide a comprehensive view for mapping and redesigning business processes. Involve a broad range of stakeholders in the design, development, use, and maintenance of digital solutions (Figure 11).

BOX 4. Using the Guidelines to Leapfrog with New or Updated Digital Solutions

The levels of maturity of the three pillars in the guidelines act as practices to follow when implementing new or updated digital solutions. When developing functional and technical requirements, the team should aim at the advanced level and adjust according to feasibility and availability of preconditions, instead of aiming at the foundational level. It is important for implementers to recognize that solutions at the advanced level are not necessarily more complicated when the necessary data is available. Furthermore, they need not be more expensive, especially when considering maintenance and risk management.

Specific attributes can also help countries leapfrog to digital transformation. Prioritizing adaptive and forward-looking solutions will lead to improved investments in technology, ultimately extending their lifespan and implying less exposure to cyber risks. By adopting a flexible and scalable architecture at intermediate and advanced levels, it becomes possible to iterate and make gradual improvements while also replacing outdated components in a cost-efficient manner.

Figure 11. Stakeholders of PFM Systems

Functional area system managers and administrators	• Functional manager (also know as initiative sponsor or business owner). • Project manager: Person in charge of developing or supervising the development of requirements; usually the custodian of the oversight of the data architecture in charge of ensuring the coherence of the data and the update of necessary catalogs. • Functional area support team: Provides technical assistance and training to internal users to promote comprehensiveness and quality of the data.
Development, support, and maintenance	• IT project lead: The lead role would have a panoramic view of the different systems of the ministry, how they interact, programming guidelines and restrictions, and security considerations. This role will need permanent and strong communication with the project manager. • Development team: The role is usually fulfilled by a team in an IT department inside of the ministry of finance, an external IT service provider, or a mix of both.
Legal departments	• Legal experts assist by identifying laws and regulations that support or generate bottlenecks in the digital process. Their role also includes drafting and promoting legal reforms to enable a digital transformation.
Internal users	• Government users. • Data capturers (according to the PFM function, can be from the ministry of finance, other agencies, other public sector entities, or other levels of government). • Institutional management (use data and reports for decision making).
External users	• Oversight institutions (for example, legislature, auditor, fiscal council, anti-corruption agencies). • External public users (for example, academia, civil society organizations, external rating agencies). • External partners for third-party data (for example, for tax receivables and payment, procurement).

Source: Authors.
Note: IT = information technology; PFM = public financial management

5. **Conducting technology research:** Conduct thorough research to identify digital solutions and technologies that can address priorities and objectives identified in step 2. The same problem could be addressed with different approaches and using different technological solutions (Box 5). Explore emerging technologies and consider factors such as cost, scalability, security, and compatibility with existing systems. Solutions could include a mix of open-source and proprietary options.[20]

BOX 5. Improving Payment Systems with Different Technologies

In Brazil, to control and improve the effectiveness of a targeted cash transfer program, the government developed an internet portal and mobile apps for citizens to self-enroll, used Big Data to verify eligibility, and expanded the use of digital payments through a real-time bank transfer tool.

In Costa Rica, the IMF Fiscal Affairs Department and Ministry of Finance organized a hackathon seeking to improve the payment system for social programs. Six solutions were developed, two of which were selected as the winning solutions. "Vision 360," based on microservices, would reduce the time for a payment and verify it against a central payee database. "Sury," an e-wallet app, would provide different user interfaces for daily payments.

20 In choosing open source, consider the levels of maturity of the attribute "reusability" of the IT architectural pillar.

6. **Analyzing development choices and selecting the right one:** Consider modular and loosely coupled architectures,[21] which can include a mix of in-house, bespoke,[22] and COTS solutions.[23] The team should also strive for vendor-agnostic[24] solutions and greater data ownership.[25]
7. **Conducting user analysis and prototyping:** Conduct user analysis to ensure that digital solutions meet user needs.[26] Prototype, test early,[27] and implement solutions in a collaborative environment. Consider user experience to improve data quality and reduce reporting costs (Box 6).

BOX 6. Using User-Centered Design to Improve Quality of Data in Mexico

In 2018, Mexico's Ministry of Finance launched a new system to improve the reporting of subnational government expenditures. The system is a web-based platform that allows subnational governments to submit their financial data in a standardized format (Global Initiative for Fiscal Transparency, Ministry of Finance, Public Credit of Mexico 2018). The system is an example of how user experience can be used to improve government services and has been successful in improving the reporting of subnational government expenditures. The user experience includes user-friendly interface, with gamification elements for reporting, clear and concise data formats, and robust and automated validations. By making it easy for subnational governments to submit their financial data, it has helped to improve the quality of the data and make it more accessible to the public. The data submitted by subnational governments is made available to the public through a user-friendly interface. This helps to ensure that the public can access the data and to hold subnational governments accountable for their spending.

8. **Identifying data sources and interoperability requirements:** Identify data sources to establish a single source of truth and promote interoperability. Consider application programming interface managers for data exchange, including its transformation when legacy systems are in place (Box 7).
9. **Developing a roadmap for implementation:** Prepare a comprehensive roadmap, considering key factors such as timelines, resources, stakeholder engagement, risk management, and monitoring. Include key milestones and ensure alignment with the broader IT strategy of the government. Establish specific, measurable, achievable, relevant, and time-bound indicators for monitoring and evaluation throughout the development and implementation process (Annex 8). Embrace an agile and iterative approach to adjust the roadmap as needed.

21 For more information refer to the IT architectural attribute "flexible and scalable" and its levels of maturity.

22 Referring to outsourced development of solutions, in which the organization does have ownership rights.

23 For more information, see Pimenta and Pessoa (2016).

24 For more information, refer to the IT architectural attribute "vendor neutral" and its levels of maturity.

25 For more information, refer to the governance and management attribute "data ownership" and its levels of maturity.

26 A survey by McKinsey revealed that governments that fail to design easy-to-use, well-designed web services risk eroding public trust and increasing delivery cost of digital services: https://www.mckinsey.com/industries/public-and-social-sector/our-insights/implementing-a-citizen-centric-approach-to-delivering-government-services.

27 Adopting an agile methodology would support adjusting the roadmap to circumvent roadblocks, whereas testing early with users would support failing fast before sunk costs are higher and it is more difficult to adjust. "Failing fast" is a concept commonly used in the context of innovation, entrepreneurship, and project management. It refers to quickly and intentionally identifying and acknowledging failures or weaknesses in a project, idea, or strategy to learn and adjust. It is gaining recognition in government as well. The principles of failing fast, including experimentation, learning, and iterative improvement, can foster innovation and agility in government.

10. **Conducting continuous monitoring and evaluation:** Continuously monitor and evaluate processes to ensure they achieve desired outcomes. Use performance indicators and gather feedback from users and stakeholders. Foster innovation and embrace emerging technologies to stay ahead of evolving challenges and opportunities.

Some additional considerations for implementing digital solutions in low-income and fragile and conflict-affected states are included in Annex 7.

BOX 7. Interoperability Platform in Madagascar

The government of Madagascar, with support from the World Bank's Digital Governance Unit, has developed an interoperability platform. The platform is based on X-Road, an open-source software developed in Estonia (see Annex Box 9.3 for more information) which defines a set of interfaces and protocols. The platform in Madagascar connects the population registry to various public and private systems, enabling rapid exchange of data between them. Data interoperability between different organizations has also enabled exchange and faster delivery of services, including processing of business registrations.

Source: Based on World Bank 2021.

V. Conclusions

Despite significant investments in PFM digital solutions over the years, mainly focused on FMISs, most countries still face several challenges in fully leveraging digital technologies for effective PFM. These challenges include conceptual design issues, weak project management capacities, lack of interoperability, cyber risks concerns, and evolving needs in the PFM area. To address these challenges and drive digital transformation in PFM, it is crucial to consider digital initiatives holistically from the functional, technological, and governance perspectives.

The implementation of digital solutions and disruptive technologies requires careful design and consideration of a country's digital infrastructure and connectivity, needs, and institutional capacities. Progress in modernizing PFM functions and IT systems is not always linear, and efficient processes and degree of digital adoption may not necessarily indicate the quality of PFM institutions. Governments should seek opportunities where digital solutions can yield rapid and substantial benefits, such as improving economic predictions, integrating digitalized payments with PFM systems, and adopting data-driven analysis and decision making.

The Guidelines are aimed at supporting countries in assessing existing PFM digital solutions, designing PFM digital transformation initiatives, and developing functional requirements for new PFM IT systems that take into account IT architectural and governance and management considerations. The development of the guidelines has benefited from a combination of expert knowledge, country cases, international standards, and academic literature. These guidelines emphasize the importance of data throughout its life cycle and highlight the significance of establishing strong foundations for successful digital transformation of PFM.

By implementing the Guidelines, governments can unlock the transformative potential of adopting digital technologies in PFM to improve fiscal policy outcomes, transform fiscal operations, and enhance governance and accountability.

Annex 1. Consultation and Piloting Process in Developing the Guidelines[28]

From the very beginning, the authors of the guidelines defined that the target audience comprises practitioners and implementers of PFM digital solutions, from the policy, management, and development point of view. In this sense, the development of the guidelines has benefited from an extensive consultation and piloting process with the intended users, which helped strengthen the knowledge base and consider different perspectives.

The development of the guidelines was initiated by a working group, to which internal and external experts and practitioners have contributed. This working group was followed by a more extensive consultation and piloting process, which has included a series of workshops and meetings with various stakeholders including ministries of finance, international financial institutions, development partners, and civil society organizations, which helped define the scope and approach, obtain feedback, and test the use of the guidelines.

During the 2022 Spring Meetings, the IMF Fiscal Affairs Department held a closed-door workshop where an earlier draft of the guidelines was introduced and discussed in four thematic groups. A total of 54 practitioners—including 19 government officials[29] and seven representatives from civil society organizations[30]—joined and provided valuable feedback. Throughout the rest of the year 2022, the authors continued to collaborate with both internal and external stakeholders to improve the guidelines. The consultation process involved, for example, a design thinking session held in August 2022 and a series of follow-up meetings attended by experts of the IMF and other organizations, such as the Digital Public Goods Alliance (DPGA), Organisation for Economic Co-operation and Development, World Bank, and more. The review process also included working sessions in seminars with ministries of finance of Southeast Asia[31] and Africa.[32]

In March and April of 2023, the draft guidelines were introduced and used as guiding material at three regional interactive workshops and peer learning events, supported by the Gates Foundation and the Swiss State Secretariat for Economic Affairs. Together, these workshops hosted more than 70 participants that comprised functional and IT officials from 30 countries across three regions.[33] Participants were provided with an opportunity to learn from their peers and regional best practices, while also having the chance to assess the level of maturity of an FMIS module of their choice and develop country roadmaps with priority actions to design or update their digital solutions for PFM using the guidelines. The workshops also benefited from contributions from DPGA, GovStack, and Public Digital. This allowed the Fiscal Affairs Department to test the use of the guidelines with the intended audience and helped capture their feedback and reflections. The workshops have been particularly useful in refining the contents and structure of the guidelines

28 The authors would like to acknowledge and thank everyone who has contributed to the development of the Guidelines.

29 From Argentina, Azerbaijan, Botswana, Comoros, India, Indonesia, Kenya, Malaysia, Maldives, Mexico, Namibia, Paraguay, Rwanda, Seychelles, Türkiye, and the United States of America.

30 Open Data Charter, ODI, Collaborative Africa Budget Reform Initiative, Global Initiative for Fiscal Transparency, Infrastructure Transparency Initiative, International Budget Partnership, and Open Contracting Partnership.

31 Through the South Asia Regional Training and Technical Assistance Center.

32 Through the Africa Training Institute and Regional Technical Assistance Center for Southern Africa.

33 The first workshop was held in Vietnam for seven countries in Asia Pacific (Cambodia, Indonesia, Laos, Malaysia, Nepal, The Philippines, and Vietnam); the second in Colombia for 10 countries in Latin America and the Caribbean (Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, and Peru); and the third in Mauritius at Africa Training Institute for 13 countries in sub-Saharan Africa (Angola, Benin, Cabo Verde, Comoros, Guinea-Bissau, Madagascar, Mauritius, Mozambique, Namibia, São Tomé and Príncipe, Seychelles, Zambia, and Zimbabwe).

ANNEX BOX 1.1. Regional Findings from the Piloting Phase

South and Southeast Asia: Countries in the region shared some strengths, including maintenance of data integrity, and faced similar challenges, including concerns related to cybersecurity and lack of interoperability. Countries also highlighted problems with implementing governance strategies that help promote transparency, efficiency, and effectiveness. Based on the guidelines, they identified initiatives to (1) improve data architecture, by unifying the chart of accounts for example; (2) strengthen cybersecurity, (3) improve interoperability, and (4) develop data governance frameworks.

Southern and Lusophone Africa: Main concerns for the African countries also related to interoperability and cybersecurity. The role of governance and management brought a stronger discussion compared with other regions, including highlighting that the information technology teams tend to be small and do not have all the necessary profiles to address the digital solutions needs. Based on the assessment results, countries made plans to (1) map systems availability to improve interoperability, (2) increase transparency, (3) review the legal framework, and (4) explore open-source alternatives and readiness for using cloud solutions.

Latin America: Latin American countries reported that their major concern relates to the evolution of needs which has not been paired with what the systems support, followed by lack of interoperability. Country roadmaps included plans to (1) improve interoperability, (2) strengthen project management, (3) increase user experience, (4) enhance data analysis, and (5) publish additional open data, directly from systems. After the presentation from GovStack Initiative, participants showed a strong interest in developing shared and reusable components across the ministry, the government, and even the region.

The workshop outputs demonstrated that countries across regions and varying levels of capacity have shared interests in their digital public financial management agenda. They also illustrate how the guidelines can serve as a useful tool for countries to self-assess and identify strengths and weaknesses to prioritize action areas for reform.

and sparked the development of the DiGIT. Findings from the regional workshops are summarized in Annex Box 1.1. The guidelines and its DiGIT were also piloted in several countries in Asia Pacific and West Africa.

In this context, the guidelines provide an approach that has been tested to be applicable to economies in different regions and in different stages of digital development. The authors would like to take this opportunity to acknowledge and thank everyone who has contributed to the development of the guidelines.

Annex 2. PFM Functions and Subfunctions Covered by Guidelines

As mentioned in the Note, the functional attributes for PFM IT systems have been identified for 11 PFM functions, each with their respective subfunctions. The process of their identification is explained in the handbook, which also provides the detailed functional attributes for each subfunction in Annex Table 2.1.

Annex Table 2.1. PFM Functions and Subfunctions Covered by the Guidelines

	Function	Subfunctions
Original Input Data Functions	Fiscal forecasting and budget preparation	Preparation of macroeconomic and fiscal forecasts
		Decision on fiscal objectives/targets and budgetary ceilings
		Preparation, negotiation, and finalization of budget proposals with ministries, departments, and agencies
	Budget execution and control	Authorization of expenditure
		Authorization of adjustments
		Apportionment/budget warrants
		Reservation/precommitment
		Commitment
		Verification, accrued or certification
		Payment orders
		Payments
	Treasury and cash management	Government banking arrangements (for example, Treasury Single Account)
		Electronic payment systems
		Cash flow management
	Debt management operations	Debt monitoring and reporting
	Accounting and financial reporting	Adoption and maintenance of the chart of accounts
		Recording of financial transactions
		Recording of supplementary transactions and updating general ledger records
		Preparation of in-year and end-year financial statements
	Public investment management	Planning and allocation
		Implementation
	Performance orientation of the budget for improved service delivery	Setting performance objectives/targets and indicators
		Monitoring and reporting on achievement of objectives/targets
	Collection of tax and nontax revenues	Revenue collection by tax and customs authorities
		Nontax revenue collection by ministries, departments, and agencies
Functions of Intermediate Use of the Data	Fiscal risks management and disclosure	Management and disclosure of fiscal risks
	Dissemination of fiscal information and PFM outcomes	Management of a transparency digital platform
	Internal audit	Audit planning
		Exchange of information and conduct of audit
		Audit findings and recommendations and follow up

Source: Authors.

Note: PFM = public financial management.

Annex 3. Functional Attributes per Level of Maturity

Annex Table 3.1. Functional Attributes per Level of Maturity

	Foundational	Intermediate	Advanced
	1.1. Stage of Transformation		
1. Process Transformation	The business processes are embedded in the PFM IT system, with some steps still manual (for example, signature, additional exchange of hard copies or digital documents) ("digitization").	The business processes are embedded in the PFM IT system to be digital by default, with no manual intervention ("digitalization").	The business processes are reviewed and streamlined to be digital by design, including the adoption of digital innovations to transform the processes ("digital transformation").
	1.2. Automation of Controls		
1. Process Transformation	The system automatically checks that data are consistent and that its processes comply with a country's business processes and rules based on the PFM legal framework, which has been redesigned and streamlined to accommodate digital reforms; it generates control/exception notifications if these requirements are not met.	The system facilitates the enforcement and oversight of government's fiscal objectives and rules through the PFM framework such as budget planning, budget execution, and financial plans/reports.	The system monitors unexpected or possible future deviations from the government's fiscal, budget, or financing plans (including as a result of mismanagement) by adopting digital innovation tools such as ML and/or robotic process automation.
	2.1. Accessibility		
2. Data Capture	Users access the system online through a network outside of the ministry of finance, to input data into the system, with secure access.	Users can upload data in bulk from a file or another database using automated procedures such as through ETL processes. The system is operational even in low connectivity and low bandwidth.	The system additionally allows automated and seamless capture of relevant data when requiring original input, for example, using an API. The system maintains high availability (that is, at least 99 percent) of the functions or processes minimizing potential disruption or downtime for reporting.
	2.2. Comprehensiveness		
2. Data Capture	Coverage of data captured, depending on the PFM function, is aligned with international standards, including at least Basic Practices under the coverage related principles of the IMF's Fiscal Transparency Code.	Coverage of data captured, depending on the PFM function, is aligned with international standards, including at least Good Practices under the coverage related principles of the IMF's Fiscal Transparency Code.	Coverage of data captured, depending on the PFM function, is aligned with international standards, including at least Advanced Practices under the coverage related principles of the IMF's Fiscal Transparency Code.
	3.1. Codes and Catalogs		
3. Data Architecture and Interoperability	The system uses a data architecture based on government-defined taxonomy (for example, chart of accounts), which can be easily mapped to international standards when applicable.	The system integrates codes and catalogs (for example, procurement IDs, beneficiary IDs, investment project IDs) to enable interoperability. Codes and catalogs are aligned with international standards (such as the International Organization for Standardization for dates and times, coordinates), when applicable.	The system allows having expanded codes and catalogs, or extensions for specific information[1] required by public agencies, or for strategic analysis of cross-cutting issues (for example, gender, climate, Sustainable Development Goals).

(Continued)

Annex Table 3.1. Functional Attributes per Level of Maturity *(continued)*

	Foundational	Intermediate	Advanced
	3.2. Data Structure		
	The database stores structured data, but relevant information is stored as unstructured data (for example, PDFs or scanned documents).	The database stores structured data of the main PFM processes; however, supporting information is stored as unstructured data (for example, scanned documents, emails).	The database stores only structured data. If nonstructured data is gathered, there is corresponding metadata.
	3.3. Data Exchange		
	Based on the data architecture, the system can exchange data with other IT systems manually or as a bulk transfer, for example, through ETL processes.	The system is interoperable with other core PFM systems based on relevant business process interactions, using automated procedures such as APIs or similar solutions.	The system is fully interoperable with other pertinent IT systems outside of the core PFM framework, using automated procedures (for example, APIs).
4. Data Storage	**4.1. Data Integrity**		
	All modifications that affect the original data records are captured separately, and individual data records are never overwritten.	Every addition, modification, or deletion of the data has a timestamp and user log (including users making the changes and validating data, when applicable).	Regular internal automated audits of the data (using error detection software or other) are performed to assure the data are reliable when they are gathered and used.
	4.2. Historic Archive		
	The database stores the PFM function's data of the current year and at least three prior years.	The database stores the PFM function's data for a period between three and five prior years.	The database stores the PFM function's data for ten or more years. The data is stored according to digital data archive preservation rules.
5. Information for Decision Making	**5.1. Analytical Capabilities**		
	The system generates timely and reliable automated reports according to the PFM legal framework when applicable, enabling the users to make operational and managerial decisions, and present information for audit and the legislature. The system supports limited facilities to define customized reports.	The system generates extensive automated reports based on the needs of the different organizational roles and users. The system allows extensive tailoring and personalization of reports.	The system incorporates advanced data analytics, algorithms, and models (that is, using ML or similar tools) that further support informed decision making.
6. Transparency	**6.1. Timely Publication**		
	The system allows the publication of reports online at intervals not greater than those defined in the PFM legal framework or aligned with the corresponding Basic Practice of the IMF's Fiscal Transparency Code, when applicable. The online publication is consistently available to the users (general public).[2]	The system supports the publication of in-year reports at least on a quarterly basis, within a month, or as the corresponding Good Practice of the IMF's Fiscal Transparency Code, when applicable.	The system supports the publication of monthly reports monthly, or as the corresponding Advanced Practice of the IMF's Fiscal Transparency Code, when applicable.

(Continued)

Annex Table 3.1. Functional Attributes per Level of Maturity *(continued)*

	Foundational	Intermediate	Advanced
	6.2. Open by Default		
	Data related to the corresponding fiscal reports are published in machine-readable formats; however, it lacks granularity. The publication requires manual intervention.	The granular data (including the corresponding codes and catalogs) are published in nonproprietary machine-readable formats (for example, CSV), with limited exceptions to address individual data privacy and national security. The publication is done through automated connections to the PFM IT system (does not require manual intervention).	The granular, machine-readable data set is accompanied by a data dictionary, and a data license explains the conditions for data to be used and reused. The data set is accompanied by tools for automated consumption by external users (for example, open API). When available, the data are published using international thematic open data standards or specifications (for example, Open Contracting Data Standard,[3] Beneficial Ownership Data Standard,[4] and Open Fiscal Data Package[5]).
	6.3. Progressive Disclosure		
	Comprehensive reports are made publicly available in a centralized government website for disseminating fiscal information (for example, ministry of finance website or fiscal transparency portal).	The government centralized website for disseminating fiscal information includes an explanation of the contents of the published data or reports, and visualizations or data queries.	A government portal uses progressive disclosure of information to cater to different users (for example, by using interactive visualizations, ML, or similar tools).

Source: Authors.

Note: API = application programming interface; ETL = extract, transform, load; IT = information technology; ML = machine learning; PFM = public financial management.

[1] See Rivero del Paso (2020) for an example.

[2] Online publication in websites that are frequently blocked or out of service impede full transparency.

[3] Open Contracting Partnership (2017) and Open Contracting Partnership and CoST-Infrastructure Transparency Initiative (2019).

[4] Open Ownership (2022).

[5] Rivero del Paso and Montiel (2019).

Annex 4. IT Architectural Attributes per Level of Maturity

Annex Table 4.1. IT Architectural Attributes per Level of Maturity

	Foundational	Intermediate	Advanced
1. Adaptive		**1.1. Flexible and Scalable**	
	The system has a monolithic architecture including that no business rules are coded at the database level and is, at least, web-based.	The data, service, and solutions layer are loosely coupled.	Services are decomposed and are broken down into small, independent, and loosely coupled components that allow adapting to new forms of solutions architecture.
		1.2. Vendor Neutral	
	The products and/or services have low coupling such that it is possible to change them with minimal effort, and adaptations, changes, and maintenance can be done internally or through other third-party providers.	The system adopts standardized interfaces and protocols that would allow seamless communication and data exchange between different solutions. The system is based on a modular design, enabling the integration of additional components or services from various vendors or in-house development.	The system has a vendor-agnostic architecture and design, ensuring flexibility to switch or integrate vendors without disruptions. The system leverages a dynamic ecosystem that facilitates seamless integration with multiple vendors.
		1.3. Cloud-Enabled	
	The system needs to be run in on-premise servers and does not allow migrating to the cloud.	The system allows for hybrid/partial use of cloud, or can be configured for the cloud; however, it is not cloud native.	The system is cloud native. When cost, performance, security, and compliance are positive, the system runs in cloud ("cloud-when-needed strategy").
2. Anticipatory		**2.1. Forward-Looking**	
	The system runs with components that are not fully supported at present (that is, it requires extended support). Legacy components or components nearing obsolescence are continuously identified and documented.	The system runs with components that are fully supported at present. A test environment is in place to enable exploration of new technologies and systems through pilots/proof of concept, using real data, while controlling risk.	New technologies that can improve effectiveness, automate tasks, or leverage benefits are used (for example, generative AI solutions are used to improve efficiency and productivity).
		2.2. Holistic Enterprise Architecture	
	The system adheres to organizational[1] directives of enterprise architecture, including at least the application[2] and technology[3] architecture that enable system support. The related documentation is kept up to date.	The system additionally adheres to organizational directives on information and security architecture, and service management.[4] The related documentation is kept up to date.	The system additionally adheres to organizational directives on performance[5] and changes management.[6] The related documentation is kept up to date.

(Continued)

Annex Table 4.1. IT Architectural Attributes per Level of Maturity *(continued)*

	Foundational	Intermediate	Advanced
3. Pragmatic	**3.1. Once-Only**		
	A small number of data sources are shared and consumed by the system;[7] however, the system has redundancies in reporting with other systems. A mapping of data sources, including their structure, update frequency, and ownership, identifies opportunities for exchanging data with other systems, as well as potential challenges.	The system exchanges data through digital solutions developed ad hoc (for example, APIs) for each use case, as needed. The governmentwide (or organizational) data interoperability framework (National Interoperability Framework Observatory 2023) for developing optimized and secure data-sharing mechanisms, including data models, standards, and taxonomy, is followed.	The system exchanges data through a government's (or organizational) centralized data exchange hub,[8] with built-in security features. The interface used for sharing data[9] is scalable.
4. Secure	**4.1. Asset Inventory**		
	An inventory is maintained for at least the most critical digital assets of the system, including applications, workstations, hardware, software assets, code, and licenses.	All data and digital assets hosted internally or externally are identified, classified, and protected according to their sensitivity, criticality, dependency, and interdependency with other digital assets.	All data and digital assets are additionally tagged, tracked, protected (end to end), and maintained according to a compliance management policy.
	4.2. Resilient		
	The system and management of its data (processed, in-transit, or stored) meet minimum security and privacy requirements, including secure coding practices, access control and privilege management, regular software updates and patches, firewall and intrusion detection/prevention systems, and data encryption when necessary. A basic disaster recovery and business continuity plan is in place, including, at least, risk assessment and impact analysis, roles and responsibilities, and regular data backup and storage.	The system is designed to avoid single point of failure, and a layered architecture ("defense in depth") that reduces disruption is in place. If the system is considered critical, it is segmented from other systems to avoid cascade failure or spillover to other systems. A comprehensive disaster recovery and business continuity plan is in place, including recovery procedures, alternate site and infrastructure, and regular testing, at least annually.	The system is subject to regular vulnerability assessments and penetration testing to anticipate and detect threats/disruptions. Fail-over capabilities are automated to withstand or recover after a disruption. Incidents related to disaster recovery and business continuity are recorded and monitored to identify patterns and anticipate future threats/disruptions.
5. User-centered	**5.1. Adoption-Driven**		
	The system can run in different web browsers and/or operating systems. The system has a clear and intuitive navigation structure that allows users to easily move between different sections, features, or functions. Labels, menus, and navigation elements are organized logically and consistently to minimize cognitive load and improve efficiency.	The system has a responsive design[10] and streamlined workflows. The system development and its updates include conducting user research[11] to inform design decisions and conducting usability testing before the system is launched. Usability tests are done early in the development of the solutions.	The system includes error prevention and feedback mechanisms.[12] User behavior tracking is used to gain insights into user interactions and preferences to further optimize the user experience. Technology and functional administrators have access to diagnostic and analytics tools to analyze various aspects of system's performance and user interactions.

(Continued)

Annex Table 4.1. IT Architectural Attributes per Level of Maturity *(continued)*

	Foundational	Intermediate	Advanced
	6.1. Contributing to Reusability		
6. Open Architecture	The system uses government- or ministrywide shared available standards and components (such as digital building block or GovStacks), based on a government registry of existing cross-shared components; however, some available components are system specific. Open-source software is not officially vetted but is sometimes used in the development of the system; however, it lacks official support, clear maintenance, or cybersecurity policies.	The system is developed or customized using governmentwide standards and components, whenever available (for example, digital public infrastructure or digital building blocks [or GovStacks]). A review process is in place for approving open-source software, including its license, support and maintenance options, overlap with existing software, integration with the existing environment, true cost of operation, and security testing.	The software components' technical documentation and licensing enable contributing to the repository of governmentwide shared solutions and/or digital public goods. Open-source software implementation frameworks are adopted and adhered to. Open-source software is properly managed, supported, and secured, like any other critical system in the organization. When using open source for mission critical systems, managed open-source software[13] is given a priority.

Source: Authors.

Note: AI = artificial intelligence; API = application programming interface; IT = information technology.

[1] Or government wide, when available.

[2] The supported technologies and platforms for system development for which the organization is prepared to ensure maintenance.

[3] The hardware and network infrastructure necessary to support the system, scalability, availability, and performance requirements.

[4] Specifying how the system's services are to be managed, monitored, and supported, including service levels and user support processes.

[5] Monitoring, performance metrics, and optimization strategies.

[6] Defines how changes to the system will be managed and tested. Addresses version control, deployment procedures, and rollback plans.

[7] Using mechanisms such as CSV, or an XML format such as JSON.

[8] Here, centralization refers to the repository and not necessarily centralized control over the data.

[9] APIs, repositories, and web services (SOAP or REST).

[10] Which allow use through various devices, such as desktops, tablets, smartphones, and different monitor sizes, to accommodate different user preferences.

[11] Contemplates conducting user interviews and surveys to gather qualitative and quantitative data, performing user journey mapping and task analysis to optimize user workflows, and applying information architecture principles to organize and structure the system's content and functionality. The design process should also consider understanding the users' needs and goals. This can be done by creating personas and scenarios or similar methodologies. Personas and scenarios are essential tools in user-centered design that help inform the development of user experiences. Other techniques include user journeys and user stories. These are complemented with wireframing and prototyping.

[12] To provide real-time feedback and error prevention mechanisms to guide users in entering accurate data and avoiding mistakes.

[13] Open-source software that has third-party support options.

Annex 5. Governance and Management Attributes per Level of Maturity

Annex Table 5.1. Governance and Management Attributes per Level of Maturity

	Foundational	Intermediate	Advanced
1. Legal Framework	**1.1. Regulating Digital Components**		
	Some digital PFM functions included in the coverage of the guidelines are supported by the legal framework.	All of the digital PFM functions included in the coverage of the guidelines are supported by the legal framework. The legal framework does not require additional manual intervention (that is, digital signatures, hard copies), enabling the process to be digital by default.	The laws and regulations envisage details such as frequency, timeframes, roles and responsibilities, procedural requirements, oversight, and responsibility mechanisms, as applicable.
	1.2. Transparency in Digital Form		
	The government has enacted legislation to enable right to access to public information and transparency of the PFM functions with clear processes and procedures.	The legal framework for right to information and/or transparency requires prioritizing the delivery of information in human and machine-readable formats to requests that apply to PFM functions.	The legal framework for right to information and transparency requires proactive publication of information in human and machine-readable formats to requests that apply to PFM functions.
	1.3. E-archives		
	The legal framework provides guidance on retention and preservation of PFM records, including responsible authorities for recordkeeping; defines different types of legal retention periods for PFM data, with at least 10 years in hot storage for critical data; and specifies any exemptions and access criteria.	The legal framework recognizes born-digital records as legally valid. Regulations provide for contemplate metadata management; policies for preservation of PFM data, data selection, and access; and infrastructure for archiving.	The legal framework incorporates provisions for technical standards for electronic record formats and e-archive management; regular audits and compliance assessments; and legal safeguards for the authenticity and admissibility of electronic records.
	1.4. Procurement		
	The legal framework provides the basis for e-procurement, including, at least, provisions for electronic submission of bids. Exceptions to the procurement law are not overused.	The legal framework embraces e-procurement for all stages of procurement and procurement types. It encourages agile and iterative procurement cycles and includes legal safeguards for agile procurement approaches, such as clear evaluation criteria and competition.	The legal framework provides for dynamic purchasing systems, framework agreements, and flexible procurement procedures. It includes provisions for monitoring and evaluation of agile procurement projects to ensure accountability and continuous improvement. It permits the use of advanced digital tools and technologies (such as AI-based decision support systems, and smart contracts, or data analytics) for procurement optimization.

(Continued)

Annex Table 5.1. Governance and Management Attributes per Level of Maturity *(continued)*

	Foundational	Intermediate	Advanced
2. Strategic Vision	**2.1. Purpose-Oriented**		
	Clear definition of problems and objectives is required for digital PFM initiatives. A diagnostic assessment informs how the proposed solution would address the problems and is used to define the project's scope and nature.	Key performance indicators are developed to monitor the effect of the digital solution.	The monitoring of the indicators and associated feedback are systematically integrated with further iterations of the digital solution.
	2.2. Data-Driven		
	Strategic policy documents refer to data and their potential to improve services. Data are collected and used, at least, in the forecasting and monitoring of macro-fiscal aggregates.	Some data-driven initiatives, aside from macro-fiscal aggregates, are in place; however, they are not yet fully integrated into the PFM operations.	Data are systematically used to inform decision making, improve operations, and develop or improve public service delivery.
	2.3. Enabling Innovation		
	There is a governmentwide digital strategy that recognizes that innovation requires change in people (including organization culture), technology, and processes.	The national digital strategy is accompanied by required resources and incentives for innovation initiatives. The ministry of finance (or corresponding PFM agencies) plays an active role in such digital strategy.	The government has tools for innovation, such as regulatory and technology sandboxes, in which the ministry of finance plays an active role (either as user and/or coordinator).
	2.4. Collaborative Environment		
	The organization in charge of the digital strategy engages with relevant internal stakeholders in other agencies, informs external stakeholders (for example, citizens and businesses) of its decisions, and consults them where necessary.	The culture across government agencies rewards collaboration and sharing of data and competencies.	Policies and mechanisms that help achieve whole-of-government coordination are actively used in the development of digital solutions for PFM. Digital building blocks are shared government wide and considered in new developments.

(Continued)

Annex Table 5.1. Governance and Management Attributes per Level of Maturity *(continued)*

	Foundational	Intermediate	Advanced
3. Project Management	**3.1. Project Design**		
	All digital PFM projects are backed by (1) functional, (2) technical, (3) performance, (4) security, (5) user experience, (6) integration, and (7) testing and quality assurance requirements. New projects require all these elements before any coding is started.	The digital projects are aligned with other government strategies (that is, national digital strategy); are supported by a strong business case; require an assessment of existing assets, resources, and systems; and include a formal framework for testing and improving.	The digital projects team has developed a flexible roadmap to accommodate unexpected delays or changes and has adopted an approach that aims for short iterations and continuous improvement.
	3.2. Project Procurement		
	The procurement processes are conducted electronically for the planning, bidding, and award stages. There is a project procurement manager who communicates with vendors and documents and negotiates service contracts. The launch of the tender requires a review of existing digital assets across government.	The e-procurement platform interacts with the budget execution systems to enable monitoring of any changes in the procurement contract from the award to the payment stages.	Procurement contracts are agile, modular, and based on relevant standards and regulations. Contracts provide for measurable performance metrics, conducting regular quality assurance activities, and having a defined governance structure for decision making and issue resolution.
	3.3. Project Implementation		
	The project team includes IT professionals and business users who meet regularly to monitor progress. There is an implicit agreement on the objectives, roles, responsibilities, and deliverables among key internal stakeholders.	The project team meets regularly and keeps a record of the progress. All stakeholders and objectives are identified, and there is an explicit agreement on the roles, responsibilities, deliverables, and timeline (for example, in an action plan).	The project manager has a project management professional or similar certification and uses key performance indicators to measure project status. Roles and deliverables (with deadlines) are clearly defined, assigned, and tracked according to the positions.
4. Data Governance	**4.1. Management Structure**		
	A governmentwide data strategy or governance framework provides the necessary data infrastructure and data architecture for PFM IT systems (for example, data registers, standards and a common taxonomy for data exchange, and guidelines for reporting).	The data governance framework covers the entire data value cycle, adapts or reengineers legacy practices, and provides more advanced data infrastructure (for example, APIs and cloud-based solutions) to further support sharing and reuse of data. It includes data classification policies (including how private data is collected, used, exchanged, secured, and destructed or declassified).	The data governance framework is robust and comprehensive. It covers all the key components, enables data exchange across relevant IT systems, ensures proper management of data, and promotes transparency and efficiency in the use of data.

(Continued)

Annex Table 5.1. Governance and Management Attributes per Level of Maturity *(continued)*

	Foundational	Intermediate	Advanced
	4.2. Data Ownership		
	The government has some ownership and control over the underlying databases related to PFM functions; however, vendors manage the data, limiting the government's control over data storage, security, and use. Data access restrictions hinder the potential of data analysis. Data migration challenges arise as a result of the lack of ownership rights.	Some restrictions on data access exist, and efforts are made to enhance decision making and analysis, allowing the use of data for third-party solutions selected by the government. Challenges in data migration persist but are mitigated through negotiated ownership rights.	The government has complete data ownership and control. It has full authority over data storage, security, and usage. This enables informed decision making and analysis. Data migration is seamless, as the government possesses unrestricted ownership rights, ensuring flexibility and autonomy.
5. Data Protection	**5.1. Data Ethics and Privacy**		
	Digital PFM initiatives that involve personal data include a clear statement on the purpose of data collection, a guidance on the appropriate and ethical use of data, and adequate safeguards for data privacy.	There are formal requirements for ensuring privacy protections and ethical use and management of data in regard to all digital initiatives regarding data collection, processing, sharing, use, and reuse.	There is a comprehensive data ethical framework that supports and complements data privacy laws, as well as required criteria for the uses of data in AI models or similar.
6. Digital Risks Governance	**6.1. Risk Management**		
	Critical digital PFM solutions are identified and risks around them are managed in an ad hoc manner. There are basic policies and standards to guide administration and operations of critical digital assets.	A digital risks register (for digital assets) and a governance structure with a designated role for management and oversight of digital risks are in place. Senior management are aware of operational risk management. Digital risks management is integrated into the enterprise risk management.	There is robust digital risks management at different levels covering different perspectives (strategic, operational, and ad hoc perspectives). Digital resilience capabilities are in place and are tested and proven to be able to anticipate and mitigate potential risks. There is visibility and awareness of potential risks and their management within and outside the organization.

Source: Authors.

Note: AI = artificial intelligence; API = application programming interface; IT = information technology; PFM = public financial management

Annex 6. Functional Attributes Applied to a Specific PFM Function

Annex Table 6.1. Example of Treasury Management (Government Banking Arrangements)

1.2. Automation of Controls		
General (Annex 3)		
Foundational	**Intermediate**	**Advanced**
The system automatically checks that data are consistent and that its process complies with a country's business processes and rules based on the PFM legal framework, which has been redesigned and streamlined to accommodate digital reforms and generate control/exception notifications if these requirements are not met.	The system facilitates the enforcement and oversight of governmental fiscal objectives and rules on PFM such as budget planning, budget execution, and financial plans.	The system monitors unexpected or possible future deviations from the government's fiscal, budget, or financing plans (including from mismanagement) by adopting digital innovation tools such as ML or robotic process automation.
For Treasury Management: Government Banking Arrangements (Handbook)		
Foundational	**Intermediate**	**Advanced**
The system controls that each payment order processed is using the appropriate means of payment established by the Treasury. The system controls the balances of each bank account or subaccounts before processing and registering a payment order generated by a system's accounting module in the general ledger. A well-evolved automated daily bank reconciliation mechanism based on bank statements and well-defined settlement rules (for example, gross/net values) is supported by the system to assure the registration of all transactions made by the government banking arrangements in the general ledger.	The system controls that each payment order processed is using the predefined means of payment (preferably by electronic means) established by the Treasury. The system allocates automatically the revenues collected in the corresponding bank account or subaccount based on rules defined by the chart of the accounts and organizational catalog, registering this information in the general ledger. A well-evolved automated online bank reconciliation mechanism based on bank statements and well-defined settlement rules (for example, gross/net values) is supported by the system to assure the registration of all transactions made by the government banking arrangements in the general ledger.	A well-evolved automated real-time bank reconciliation mechanism based on bank statements and defined settlement rules (for example, gross/net values) is supported by the system to assure the registration of all transactions made by the government banking arrangements in the general ledger. The system automatically monitors any unexpected (or possible future) deviations from the financing plan based on the payment orders processed and detects potential cases of financial mismanagement and risks of corruption by adopting advanced data analytics tools (such as AI/ML applications).

Source: Annex 3 and Handbook (forthcoming).

Note: AI = artificial intelligence; ML = machine learning; PFM = public financial management.

Annex 7. Implementing PFM Digital Solutions in Low-Income and Fragile and Conflict-Affected States

Low-income and fragile and conflict-affected states can also aim to leapfrog from having simple or no digital solutions to advanced digital solutions for certain PFM functions. Their efforts should be guided by the following considerations, which can also be applicable to other countries at a relatively early stage of digital transformation of PFM.

- *For digital solutions, prioritize PFM functions with the highest effect*. Start by investing in core PFM functions that imply major human resource burden and have a higher macro-fiscal effect, considering the number of transactions and proportion of the budget. Such investments could include, for example, digital disbursement of payroll, integration of planning and monitoring of public investments into a consolidated portfolio, and automation of controls during budget execution.
- *Invest time in reviewing and reengineering PFM processes*. Ensure that sufficient time is spent on mapping and transforming practices to be digital by design. This is an essential step in any digital reforms that will allow maximum efficiency gain and should not be omitted in any case.
- *Use the advanced levels of maturity in the guidelines as main reference*. Recognize that advanced-level solutions are not always more complex or expensive to implement, particularly when key digital building blocks are relatively straightforward to acquire and there is no burden of transitioning from a legacy system. Although it might not always be feasible, prioritizing forward-looking solutions will make for better investments in technology and prolonging their lifespan. Implementers should bear in mind that forward-looking solutions are not necessarily more costly when factors such as maintenance and risks management are considered. A flexible and scalable architecture in the intermediate and advanced levels will also allow implementers to iterate, improve digital solutions in a paced manner, and replace obsolescent components in a more cost-efficient way.
- *Adapt existing digital solutions*. Explore adapting existing digital solutions from other countries or contexts to suit local needs. Applications documented as digital public goods or bilateral memorandums of understanding among countries can provide a starting point and accelerate the deployment of advanced digital solutions. Open-source solutions can provide cost-effective alternatives, allowing customization and localization to meet specific needs. Prioritize managed open-source solutions when critical processes are involved, and consider maintenance costs as part of the project.
- *Tailor solutions to the local context*. Recognize local challenges and needs, such as internet access and energy disruptions. Ensure that digital solutions are prepared for low bandwidth and the system allows offline mode to save data in cache when internet access is down, connecting with the servers when it is back online. When targeting citizen services, prioritize mobile-based solutions, given the widespread use of mobile phones. Multichannel services delivery can bridge the digital divide and provide access to digital solutions even in areas with limited infrastructure.
- *Test digital solutions early*. Begin with small-scale pilot projects in specific sectors or regions. Test the feasibility, effect, and acceptance of digital solutions in real-world scenarios before scaling up. Testing early will allow adjusting the strategy and the solutions before sunk costs are too large.
- *Ensure proper documentation and ownership rights*. Whether the digital solution development is COTS, in-house, or bespoke, ensure that the delivery of full technical and functional documentation is part of the project and that the components can be maintained by third-party vendors. If the development is

COTS, ensure that the government has the rights to its content in the database to exploit, mine with third-party services, and transfer to a new database when necessary.

- *Foster partnerships*. Seek partnerships with international development organizations, nongovernmental organizations, and other stakeholders who can provide technical expertise and resources to accelerate digital transformation efforts. Partnerships with the private sector such as technology companies and startups, both local and international, could also support improving the technical expertise and access to emerging digital services.
- *Build enterprise architecture and capacity*. Generate incentives to build the digital skills and capabilities of government officials, civil society, and the wider population. Build a technology team with clear roles to maintain the digital solutions and manage cyber risks.
- *Adopt policy and regulatory frameworks*. Develop appropriate policy and regulatory frameworks to support digital transformation, including procurement of digital components. Address issues such as data protection, privacy, cybersecurity, and digital rights to build trust and confidence in digital solutions.
- *Secure long-term commitment*. Recognize that digital transformation is a long-term endeavor which requires sustained commitment and resources from the government and stakeholders involved. Continuously evaluate progress, adapt strategies, and invest in scaling successful digital initiatives.

Annex 8. Indicators for Digital PFM Strategies

Indicators related to the improvements in process and execution are relevant for digital projects. However, it is also important to consider indicators that allow measuring the effect of digital solutions on different aspects of PFM, depending on the selected PFM function and the problem that has been identified to be addressed through a digital solution. Annex Box 8.1 includes examples of indicators at the output and outcome levels as a reference.

ANNEX BOX 8.1. Examples of Indicators

Cost savings

- Reduction in administrative expenses
- Decrease in procurement costs
- Reduction in duplicate payments
- Cost savings from streamlined budget execution

Enhanced efficiency

- Efficiency gains in financial processes
- Decrease in transaction processing time

Improved policies

- Increased alignment of budget allocations with policy priorities
- Enhanced accuracy in revenue forecasting
- Enhanced accuracy in budget forecasting
- Strengthened compliance with fiscal rules and regulations
- Reduction in budget variances between planned and actual expenditure
- Improved policy outcomes through effective resource allocation

Improved transparency

- Improved budget transparency as assessed internationally
- Better quality of open data
- Improved tracking and audit trail of financial transactions

Annex 9. Developing PFM Digital Solutions for Reusability: Identifying the Building Blocks

Traditionally, government agencies create their own systems or digital solutions to provide services tailored to the needs of a particular group of citizens or businesses. However, this approach may not always be the most efficient. Developing digital solutions for reusability in government means creating software solutions and applications that can be easily and efficiently reused by other government agencies or departments. Solutions can also be shared across governments, and with businesses or citizens, depending on the scope and objectives. Reusability is an important approach that promotes interoperability, efficiency, and cost savings, as it allows governments to avoid duplication of efforts and resources to create similar solutions.

Developing for reusability typically involves designing software solutions and applications in a modular way, with clear and well-defined interfaces and components that can be easily integrated with other systems. This enables governments to develop a library of reusable components that can be quickly and easily assembled to create new digital solutions. Developing for reusability also involves using open standards and technologies that are widely adopted and interoperable with other systems. This enables governments to avoid vendor lock-in and choose the best solutions based on their needs, without being constrained by proprietary technologies. Three main concepts related to reusability, which are related but have different purposes and scopes, are government digital building blocks (that is, Government Stacks or GovStacks), digital public infrastructure (DPI), and digital public goods.

- *GovStacks* are sets of technologies and software solutions conceived as building blocks specifically designed to be shared within governments to modernize and streamline their operations, and to optimize the purchase of technology. They are modular, easily integrated, and can be reused by various government agencies with similar needs, reducing redundant development efforts. GovStacks are built using open standards, promoting interoperability, and reducing vendor lock-in. They are flexible and adaptable to the changing needs of government agencies. They are typically developed to address specific needs and challenges faced by government agencies, such as improving data management, citizen engagement, or service delivery.[34] GovStacks are focused on providing government agencies with the tools they need to operate more efficiently, transparently, and accountably (see Annex Box 9.1).
- *DPI*, on the other hand, refers to the foundational technologies that enable the delivery of digital services by governments (Annex Box 9.2). This includes secure digital identity systems, e-payment, and data exchange platforms. DPIs are typically designed to be interoperable across government agencies and are often built using open standards. While GovStacks are intended to be used primarily by government agencies and their staff, DPIs can also include online services that citizens and businesses use to interact with the government. GovStacks are typically owned and managed by government agencies or consortia of government agencies, whereas DPIs can be owned and managed by a mix of public and private sector entities. DPIs may also involve collaborative governance models that involve multiple stakeholders, including government agencies, private sector companies, and civil society organizations.
- *Digital public goods* are open-source software, open data, open AI models, open standards, and open digital content that protect privacy and adhere to other applicable laws and best practices (Annex Box 9.3). They do no harm by design and could help countries attain their Sustainable Development

[34] See for example GovStack. "Use Case Simulation, Unconditional Social Cash Transfer Unconditional Social Cash Transfer."

Goals (Digital Public Goods Alliance 2023). For example, some countries have adopted data schemas proposed by international civil society organizations to identify the data fields within their systems or for publications in addition to observing the Government Finance Statistics standards for registering financial transactions.

In summary, GovStacks are focused on providing government agencies with specific software solutions, whereas DPIs provide the foundational technologies necessary for digitalization of several dimensions of the economy, including service delivery. Digital public goods, on the other hand, are open-source products and services designed for public good or interest. They can all promote reusability of digital solutions.

ANNEX BOX 9.1. Singapore Government Tech Stack

The Singapore Government Tech Stack is a suite of digital tools and infrastructure used by the Singaporean government to drive digital transformation and deliver public services more effectively. It is managed by the Government Technology Agency (GovTech) of Singapore. It is designed to be modular and interoperable, allowing different government agencies to use different components according to their specific needs. It aims to provide government agencies with a set of open-source technologies and software solutions that can be used to modernize and streamline their operations. It comprises several components, including:

- NECTAR—a cloud-based platform-as-a-service which streamlines and accelerates the process of application development. Built on open-source Docker technology in which the application code is packaged into containers that run identically on a developer's machine or on any other cloud provider that supports Docker, NECTAR reduces the risk of an application malfunctioning as a result of differences in hardware configuration, or disparities between testing and production environments.
- Governmentwide application programming interface exchange—APEX—that serves as a searchable library of application programming interfaces. Authentication protocols on APEX ensure that only authorized applications have access to highly confidential citizen data. At the same time, activities on the APEX platform are tractable as the system audits and logs the applications that have requested to pull data from government databases.

By providing these components as open-source technologies, GovStack Singapore aims to reduce the time and cost required for government agencies to develop and deploy digital applications, while also promoting interoperability and collaboration across different agencies and departments. The Singapore Government Tech Stack is constantly evolving, with new components being added and existing components being updated and improved over time.

Source: GovTech Singapore (https://www.tech.gov.sg/products-and-services/).

ANNEX BOX 9.2. Digital Public Infrastructures in India

In India, digital public infrastructures (DPIs) have played a critical role in promoting financial inclusion and enabling citizens to access a range of digital services from the public and private sectors. The approach shifts the thinking from platform-centric model to protocol-based systems; the items included have later been coined as DPIs. India's DPIs are a set of applications and systems powered by interoperable open standards and protocols that allow programmatic and secure access by the public and private sector to the underlying data and business logic through application programming interfaces that enable secure, paperless, and cashless transactions and identity verification. They consist of three main layers:

- Identity layer, the Aadhaar system: Provides citizens with a unique digital identity based on biometric and demographic data. Aadhaar is basis for a range of services, such as using eSignature and performing Know Your Client electronically and has also played a critical role in facilitating opening bank accounts, obtaining loans, filing taxes, and the delivery of social welfare programs, such as Direct Benefit Transfer.
- Payments' layer, the Unified Payment Interface: Payment system that enables citizens to make digital payments directly from their bank accounts using their mobile devices. The Unified Payment Interface has been instrumental in promoting cashless transactions, which helps to curb corruption and promote financial inclusion.
- Data layer, which refers to the Data Empowerment and Protection Architecture: Aims to restore the ownership and control over user data to its owners. This is done through the DigiLocker system, which allows citizens to store and share their documents electronically; a Consent Artifact, that allows capturing user consent to share their personal data with third parties; and consent managers that provide an interface to facilitate the "easy sharing and consumption of data from various entities with user consent."

The components of India Stack, which form India's DPIs, are operated and maintained by different agencies within the government.

Sources: India Stack (https://indiastack.org); Alonso and others 2023; Vir and Sanghi 2021.

ANNEX BOX 9.3. Digital Public Good: X-Road Estonia

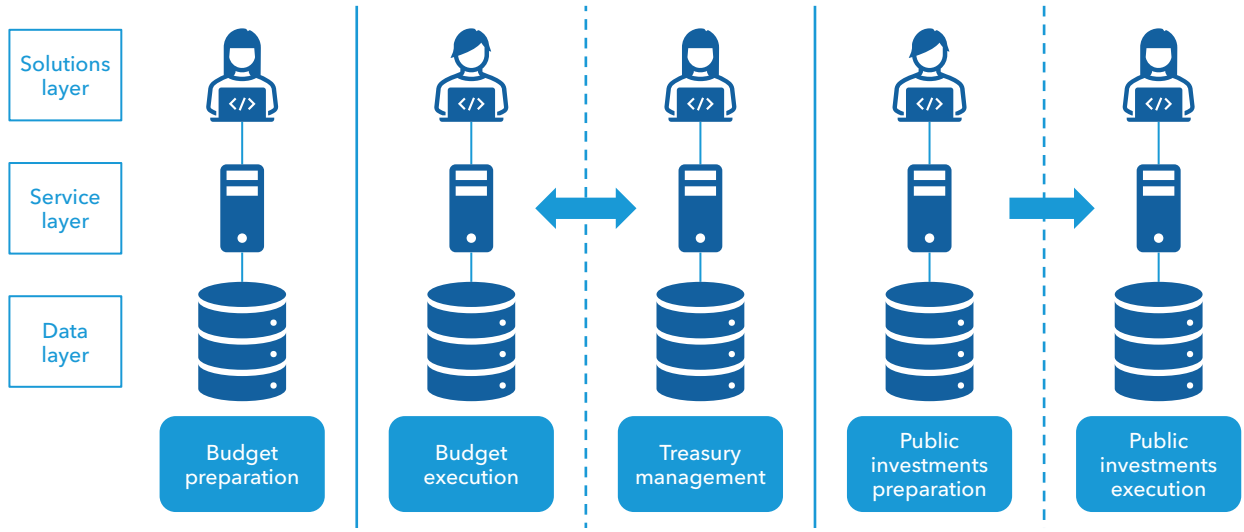
X-Road is a secure and decentralized data exchange platform originally developed in Estonia for use by the government, but now widely used by both public and private sectors in various countries. It enables different organizations to securely exchange data and services over the internet, with built-in security features such as access control, authentication, encryption, and auditing. X-Road provides a standardized interface for data exchange, making it easier for organizations to connect and collaborate, while ensuring the confidentiality, integrity, and availability of the data exchanged. As it has been developed as a digital public good, several countries have used X-Road to develop their own application programming interface's gateway management.

Source: X-Road (https://x-road.global/).

Annex 10. Developing PFM Digital Solutions with Interoperability

Interoperability, defined as the seamless, secure, and controlled exchange of data between IT systems or applications, brings many benefits to governments. However, several papers analyzing the shortcomings of government digital initiatives point to a siloed approach to developing government systems including FMISs. The siloed approach implies that the data will be controlled and administered by one department or unit in isolation from the rest of an organization. Annex Figure 10.1 depicts a common configuration of PFM IT systems in which each PFM function is managed separately, with only few functions having one- or two-way interoperability with others. The main reasons for such siloed structure are (1) lack of collaboration across government agencies, (2) absence of a data governance policy and/or inadequate recognition of the strategic value of fiscal data, and (3) legacy IT systems that pose challenges for interoperability with newer systems. Siloed systems entail several problems, as discussed in Annex Box 10.1.

Annex Figure 10.1. Current Common Siloed Setup of FMIS



Source: Authors.
Note: FMIS = financial management information system.

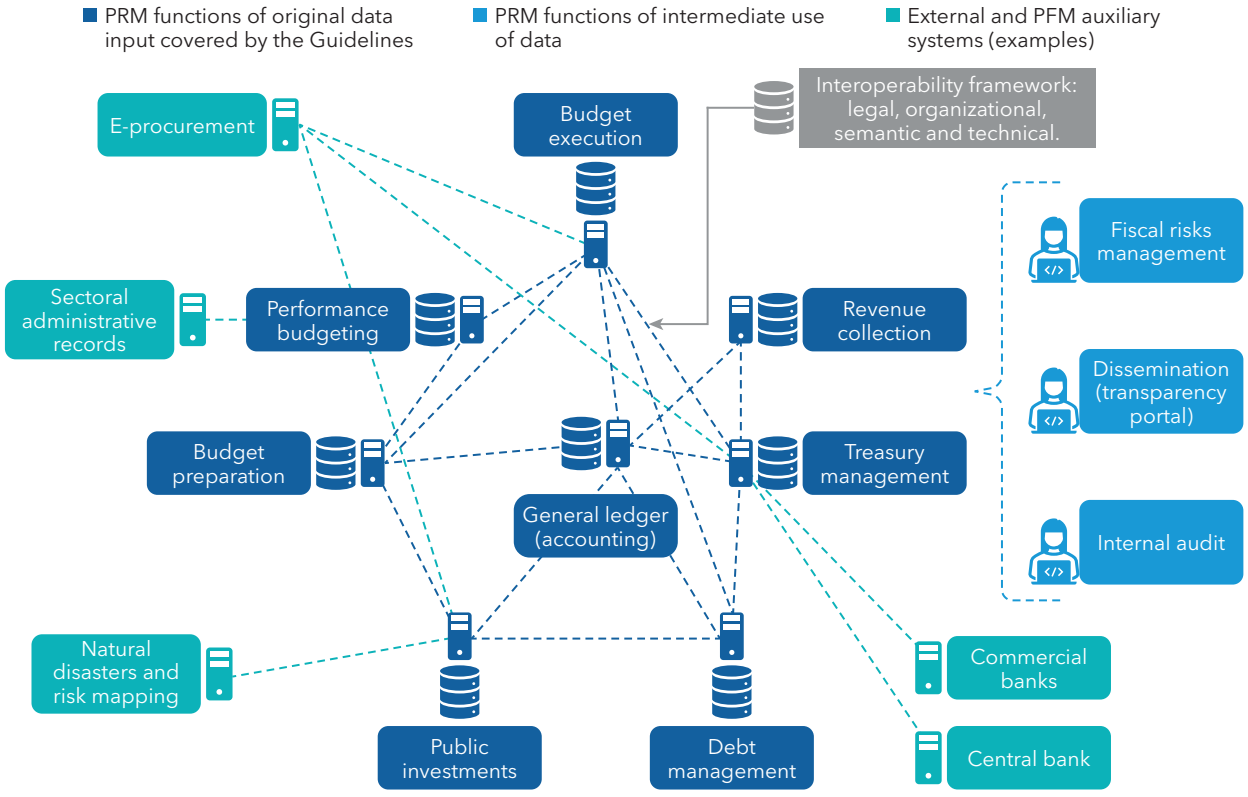
In a desirable setup, in which the ministry of finance is capable of data-driven decision making, different PFM IT systems should have a data architecture and a service layer that allow them to interoperate and exchange data as needed. The advantage of interoperability is that it does not require unification and integration, as it relies on communication and interaction between different systems. This can be particularly helpful when dealing with legacy systems and/or when systems follow a modular development approach.

The approach of interoperability should also be applied more broadly to create one- or two-way connections even with systems and data sources outside of the ministry of finance (Annex Figure 10.2). This can be for automation and control of government functions that require data from other governments and/or private or open systems (for example, the interoperability between the treasury module of an FMIS and systems of private banks for government payments and bank reconciliation purposes, or the seamless

ANNEX BOX 10.1. Problems Created by Siloed Systems

- **Inconsistency and duplication**: When systems do not interoperate, there is a common need to manage separate catalogs which could create a mismatch of updates (for example, changes in the chart of accounts done in the budget execution module, but not in the public investments modules). In addition, two systems could require the same data input twice, which is also prone to error for reasons such as different cut-off dates, sources, or reporting users.
- **Costly maintenance**: Siloed systems are often developed with different technologies which create a disperse need of skills of the IT team, as well as a need to manage security specificities. In addition, they might duplicate licensing and servers needs. In sum, they result in overall costly setups for governments.
- **Difficulty to centralize**: Data distributed and stored throughout multiple systems and data warehouses become extremely difficult to centralize and normalize into one coherent view required to understand the actual standing point of the public finances. Even if data of all the different systems can be aggregated or consolidated, it is frequently time-consuming and inaccurate.
- **Costly and error-prone user management**: Managing multiple siloed systems also requires managing users separately; therefore, the addition or removal of users becomes a time-consuming and error-prone procedure. In a related form, users will require training for each separately managed system, which is also costly to an organization.

Annex Figure 10.2. FMIS Setup Enabled for Interoperability with Internal and External Systems



Source: Authors.
Note: APIs = application programming interfaces; FMIS = financial management information system.

connection between an FMIS budget execution module and an e-procurement system for control of expenditure commitments). Interoperability also helps to improve data analysis for augmented decision making. An example of this is the interoperability with georeferenced data of private or open actors, which can provide useful insights to better target or distribute budget allocations for climate change adaptation.

References

Allen, Richard, Yasemin Hurcan, Peter Murphy, Maximillien Queyranne, and Sami Yläoutinen. 2015. "The Evolving Functions and Organization of Finance Ministries." IMF Working Paper 15/232, International Monetary Fund, Washington, DC.

Alonso, Cristian, Tanuj Bhojwani, Emine Hanedar, Dinar Prihardini, Gerardo Uña, and Kateryna Zhabska. 2023. "Stacking Up the Benefits: Lessons from India's Digital Journey." IMF Working Paper 23/078, International Monetary Fund, Washington, DC.

AlphaBeta. 2018. *Digital Innovation in Public Financial Management (PFM): Opportunities and Implications for Low-Income Countries*. Singapore: AlphaBeta.

Amaglobeli, David, Ruud de Mooij, Andualem Mengistu, Mariano Moszoro, Manabu Nose, Soheib Nunhuck, Sailendra Pattanayak, and others. 2023. "Transforming Public Finance Through GovTech." IMF Staff Discussion Note, International Monetary Fund, Washington, DC.

Cangiano, Marco, Alan Gelb, and Ruth Goodwin-Groen. 2019. "Public Financial Management and the Digitalization of Payments." CGD Policy Paper 144, Center for Global Development, Washington, DC.

Cho, Chloe, and Lorena Rivero del Paso. 2023. *Digital Solutions Guidelines Implementation Tool (DiGIT)*. Forthcoming. Washington, DC: IMF.

Cooper, Julie, and Sailendra Pattanayak. 2011. "Chart of Accounts: A Critical Element of the Public Financial Management Framework." IMF Technical Notes and Manuals 11/003, International Monetary Fund, Washington, DC.

Dener, Cem, Joanna Watkins, and William Leslie Dorotinsky. 2011. *Financial Management Information Systems: 25 Years of World Bank Experience of What Works and What Doesn't*. Washington, DC: World Bank.

Diamond, Jack, and Pokar Khemani. 2005. "Introducing Financial Management Information Systems in Developing Countries." IMF Working Paper 05/196, International Monetary Fund, Washington, DC.

Digital Public Goods Alliance. 2023. "Digital Public Goods Standard." https://digitalpublicgoods.net/standard/

Fritz, Verena, Marijn Verhoeven, and Ambra Avenia. 2017. P*olitical Economy of Public Financial Management Reforms: Experiences and Implications for Dialogue and Operational Engagement*. Washington, DC: World Bank.

Global Initiative for Fiscal Transparency, Ministry of Finance, and Public Credit of Mexico. 2018. "Open Data Tutorial: Opening and Promoting Use of Budget Data." https://fiscaltransparency.net/open-data-tutorial-opening-and-promoting-use-of-budget-data/

GovStack. n.d.a "Use Case Simulation, Unconditional Social Cash Transfer Unconditional Social Cash Transfer." https://simulation.govstack.global/

GovStack. n.d.b "Our Approach." https://www.govstack.global/our-approach/

Gracida, Tarick, and Lorena Rivero del Paso. 2019. "Fiscal Transparency Portals: A User-Centered Approach." Global Initiative for Fiscal Transparency, Washington, DC.

Gray, Cheryl Williamson. 1998. *Public Expenditure Management Handbook*. Washington, DC: World Bank.

Gupta, Sanjeev, Michael Keen, Alpa Shah, and Geneviève Verdier (Eds.). 2017. *Digital Revolutions in Public Finance*. Washington, DC: International Monetary Fund.

Hashim, Ali. 2014. "A Handbook on Financial Management Information Systems for Government: A Practitioners Guide for Setting Reform Priorities, Systems Design and Implementation." Working Paper 100509, World Bank, Washington, DC.

Hashim, Ali, and Moritz Piatti. 2016. *A Diagnostic Framework to Assess the Capacity of a Government's Financial Management Information System as a Budget Management Tool*. Washington, DC: World Bank.

Hashim, Ali, and Moritz Piatti. 2018. "Lessons from Reforming Financial Management Information Systems." Policy Research Working Paper 8312, World Bank, Washington, DC.

Long, Cathal, Marco Cangiano, Emily Middleton, and James Stewart. 2023. "Digital Public Financial Management: An Emerging Paradigm." ODI Working Paper, London: ODI.

Misch, Florian, Brian Olden, Marcos Poplawski Ribeiro, and Lamya Kejji. 2017. "Nowcashing: Using Daily Fiscal Data for Real-Time Macroeconomic Analysis." IMF Working Paper 17/227, International Monetary Fund, Washington, DC.

National Interoperability Framework Observatory (NIFO). 2023. "Digital Public Administration factsheets." European Commission. https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framework-observatory/digital-public-administration-factsheets-2023

Organisation for Economic Co-operation and Development (OECD). 2019. *The Path to Becoming a Data-Driven Public Sector*. Paris: OECD Publishing.

Organisation for Economic Co-operation and Development (OECD). 2021a. *Good Practice Principles for Data Ethics in the Public Sector*. Paris: OECD Publishing.

Organisation for Economic Co-operation and Development (OECD). 2021b. *The E-Leaders Handbook on the Governance of Digital Government*. Paris: OECD Publishing.

Open Contracting Partnership. 2017. "Open Contracting Data Standard Version 1.1." https://standard.open-contracting.org/latest/en/

Open Contracting Partnership. 2019. "Open Contracting Supporting Successful IT Procurement." https://www.open-contracting.org/resources/open-contracting-supporting-successful-it-procurement/

Open Contracting Partnership and CoST-Infrastructure Transparency Initiative. 2019. "Open Contracting for Infrastructure Data Standards Toolkit." https://standard.open-contracting.org/infrastructure/latest/en/

Open Ownership. 2022. "Beneficial Ownership Data Standard Version 0.3." https://standard.openownership.org/en/0.3.0/

Pimenta, Carlos, and Mario Pessoa (Eds.). 2016. *Public Financial Management in Latin America: The Key to Efficiency and Transparency*. Washington, DC: Inter-American Development Bank.

Pimenta, Carlos, and Antonio Seco. 2021. *Financial Management Information Systems (FMIS) – Project Guide: Strategic, Functional, Technological, and Governance Issues in the Design and Implementation of New Platforms for Public Financial Management Systems*. Washington, DC: Inter-American Development Bank.

Rivero del Paso, Lorena. 2020. *Fiscal Data for Emergency Response: Guide for COVID-19*. Washington, DC: Global Initiative for Fiscal Transparency. https://fiscaltransparency.net/fiscal-openness-in-emergency-response-covid-19/

Rivero del Paso, Lorena, and Oscar Montiel. 2019. "Publishing Budget and Spending Open Data." Global Initiative for Fiscal Transparency. https://fiscaltransparency.net/publishing-budget-and-spending-open-data/

O'Neil, Kevin, and Nicole Rasul. 2021. "Co-Develop: Digital Public Infrastructure for an Equitable Recovery." Rockefeller Foundation. https://www.rockefellerfoundation.org/report/co-develop-digital-public-infrastructure-for-an-equitable-recovery/

Uña, Gerardo, Richard I. Allen, and Nicolas M. Botton. 2019. "How to Design a Financial Management Information System: A Modular Approach." IMF How to Note 19/02, International Monetary Fund, Washington, DC.

Uña, Gerardo, Alok Verma, Majid Bazarbash, and Naomi N. Griffin. 2023. "Fintech Payments in Public Financial Management: Benefits and Risks." IMF Working Paper 23/20, International Monetary Fund, Washington, DC.

Vir, Aaryaman, and Rahul Sanghi. 2021. "The Internet Country: How India created a digital blueprint for the economies of the future." Tigerfeathers, January 14. https://tigerfeathers.substack.com/p/the-internet-country

World Bank. 2021. "Madagascar's Digital Transformation Is Helping Deliver Better and Faster Services." *World Bank Blogs*. https://blogs.worldbank.org/governance/madagascars-digital-transformation-helping-deliver-better-and-faster-services

World Bank. 2022. "GovTech Dataset." https://datacatalog.worldbank.org/search/dataset/0037889/govtech-dataset

World Bank. 2023. "Financial Management Information Systems (FMIS)." https://www.worldbank.org/en/topic/governance/brief/financial-management-information-systems-fmis

Glossary

Term	Definition
Agile approach	The agile approach is a flexible method of software development that involves iterative development and the continuous delivery of working software. It is designed to help organizations respond quickly to changing circumstances and requirements and is often used in fields where the needs of the customer or user are constantly evolving. The agile approach has the advantage of being flexible and adaptable, as it allows for rapid iteration and the ability to respond to changing requirements. Compare to "waterfall approach," also included in this glossary.
Agile procurement	Agile procurement emphasizes breaking down complex procurement projects into smaller, manageable increments or sprints. This iterative approach enables gathering feedback, incorporating changes, and adjustments. By breaking down the procurement into smaller phases, public officials can prioritize and deliver incremental solutions or outcomes, allowing for early benefits realization. Regular assessments and feedback loops enable addressing potential risks or issues prompt-ly, reducing the likelihood of major setbacks.
Application programming interface (API)	An API is a set of rules and protocols that defines how different software systems can communicate with each other. APIs allow different software applications to exchange data and functionality in a consistent and predictable way. In the context of PFM, APIs can be used to allow different government systems to share financial data and functionality, such as budgeting, accounting, and reporting. This can help to improve the accuracy and timeliness of financial information and can make it easier for governments to track and manage their resources. It can also help to reduce the costs associated with maintaining separate systems and can improve the overall efficiency of government operations.
Artificial intelligence (AI)	AI refers to the development of computer systems and algorithms that can perform tasks that would normally require human intelligence, such as learning, problem-solving, decision making, or pattern recognition. AI is a broad field that encompasses a wide range of technologies and approaches, including machine learning, natural language processing, and robotics.
Big data	Big data refers to extremely large data sets that are difficult to process and analyze using traditional methods. These data sets are often characterized by their volume, variety, and velocity. Specialized tools and techniques, such as machine learning algorithms and data visualization tools, are often used to analyze big data. In the context of PFM, big data can be used as a powerful tool for making more informed and data-driven decisions.
Blockchain	Blockchain is a distributed ledger database technology that allows multiple parties to record and verify transactions securely and transparently, without the need for a central authority. It is based on a decentralized network of computers, called nodes, that each maintain a copy of the database and work together to validate and record new transactions. Blockchain technology has the potential to revolutionize the way that governments handle financial transactions and record keeping.
Born-digital	Born-digital refers to information, data, or content that is originally created and exists in a digital format, rather than being converted from a physical or analog format. Born-digital records are generated and stored electronically in digital systems from the start. They are often more easily accessible, searchable, and shareable, compared with the converted records.
Building blocks	Building blocks refer to "software code, platforms, and applications that are interoperable, provide a basic digital service at scale, and can be reused for multiple use cases and contexts" (Digital Public Goods Alliance 2023). They can be composed of many microservices and provide a standalone service, but they can also be combined and adapted to serve as a component of a larger system or stack.

Term	Definition
Commercial-off-the-shelf (COTS) software	COTS refers to software that is developed and sold by a third-party vendor for use by multiple organizations. COTS software is typically developed for a general market, rather than being tailored to the specific needs of a particular organization. It can be a cost-effective and efficient alternative to developing custom software from scratch, as it is typically developed by experienced software developers and has been tested and refined for use by multiple organizations.
Data architecture	Data architecture is the design and organization of a database or other data storage system. It includes the structure of the data, the relationships between different data elements, and the rules and policies that govern how the data can be used and accessed. A well-designed data architecture can help to ensure that financial data is organized in a logical and meaningful way, and that it can be easily accessed and analyzed.
Data dictionary	A data dictionary is a document or database that provides information about the definitions, attributes, and relationships of data elements or fields in a database or data model. A data dictionary can help to provide context and understanding about the data that is being used in a particular system or application.
Data fabric	Data fabric refers to an architectural approach that enables seamless data integration, management, and access across multiple systems, applications, and sources. It provides PFM experts with a unified and holistic view of data, allowing them to effectively analyze, use, and share information for decision-making and operational purposes.
Data field	A data field is a specific piece of information that is stored in a database or other data storage system. Each field is typically associated with a specific data type, such as text, numbers, or dates, and is used to store a single piece of data within a larger data set. Data fields are typically organized into columns in tables or other structured formats. Common examples of data fields that might be used in financial management systems include amount, date, category, and description.
Data governance	Fiscal data governance refers to the framework, processes, and practices that ensure the effective management, quality, integrity, and security of fiscal data throughout its lifecycle. It involves establishing rules, standards, and controls to govern the collection, storage, usage, and dissemination of financial data within the public financial management system.
Data inventory	A data inventory is a list or catalog of the data assets that an organization has, including information about the type, format, location, and purpose of each data asset. A data inventory can help to provide a comprehensive overview of the data that an organization has and can help to identify and manage data assets more effectively.
Data schema	A data schema is a structure that defines the organization and format of a database or data model. A data schema specifies the data types, relationships, and constraints that define the data that can be stored in the database. In the context of PFM, a data schema could be used to define the structure of a financial management database or system, helping to ensure that the data is accurate, consistent, and easy to access and analyze.
Data warehouse	A data warehouse is a central repository for storing and managing large amounts of data from multiple sources. It is typically designed to support fast querying and analysis of large data sets. Data warehouses can support informed decision making by allowing users to analyze data efficiently and effectively.
Data set	A data set is a collection of data that is organized and structured in a specific way. A data set typically consists of a set of records, each of which contains one or more data fields, and may be stored in a database or other data storage system. It can contain a wide variety of data types, including text, numbers, images, and audio, and may be stored in a variety of formats, such as a spreadsheet, a database, or a text file.
Digital public goods (DPGs)	According to the Digital Public Goods Alliance (2023), DPGs are "open-source software, open data, open AI models, open standards, and open content that adhere to privacy and other applica-ble laws and best practices, do no harm by design, and of high relevance for attainment of the United Nations 2030 SDGs." Examples of DPGs include the Open Contracting Portal, Modular Open Source Identity Platform (MOSIP), and OpenG2P.

Term	Definition
Digital public infrastructure (DPI)	The Rockefeller Foundation defines DPI as digital solutions that "enable basic functions essential for public and private service delivery, that is, collaboration, commerce, and governance (O'Neil and Rasul 2021)." DPI solutions are used widely across countries or sectors, basic but powerful and broadly applicable, and often regulated or managed by the government. DPI is also often described as a stack, with individual systems playing specific functions as layers that interface with each other. Prominent examples of DPI include digital ID, data-sharing solutions, and payment systems.
Disruptive technology	Disruptive technology refers to a new technology or innovation that significantly changes the way that an industry or market operates. It is often characterized by the ability to challenge and displace existing technologies or business models and can lead to significant changes in the competitive landscape of an industry. In PFM, disruptive technologies could include innovations that significantly change the way that government agencies manage data or provide new analytical capabilities.
Dynamic purchasing system (DPS)	DPSs are procurement mechanisms used by government entities to acquire commonly used goods, services, or works. They are designed to provide flexibility and efficiency in the procurement process, particularly for recurring or frequently needed items. A DPS functions as an electronic platform where suppliers can continually apply to join the system, and successful applicants become approved suppliers. Contracting authorities can then issue specific calls for competition within the DPS, allowing approved suppliers to bid for individual contracts. DPSs offer benefits such as reduced procurement time, increased competition, and the ability to accommodate new suppliers throughout the contract period.
Enterprise architecture	Enterprise architecture is a discipline that involves the design and planning of an organization's IT systems and infrastructure. It involves the creation of a holistic, high-level view of an organization's systems and processes, and the alignment of these systems with the organization's overall business strategy. Enterprise architecture is important in PFM as it helps to ensure that FMISs are integrated and efficiently support the organization's operations.
Error detection software	Error detection software is a type of software that is designed to identify and correct errors in data or processes. This can include things like spelling and grammar checkers, which identify and correct errors in written text, as well as more complex systems that are designed to identify and correct errors in financial data or transactions. In the context of PFM, error detection software can help ensure the accuracy and integrity of financial data and processes.
Extract, transform, load (ETL)	ETL refers to the process of extracting data from one or more sources, transforming the data into a format that is suitable for analysis or other purposes, and loading the data into a target database or data storage system. ETL processes can involve a wide range of activities, including data cleansing and transformation, data integration, and data quality checks. In the context of PFM, ETL processes are often used to consolidate and prepare data from multiple sources for analysis or reporting.
GovStack	In the context of technology, a stack refers to a set of software technologies or components that are used together to build and run an application or system. A stack typically includes components such as an operating system, a web server, a database, and programming languages or frameworks. GovStacks take a whole-of-government stack approach to digital projects, layering digital solutions on top of one another and making each solution more impactful and powerful than when used alone.
GovTech	GovTech refers to the use of technology to improve the delivery of government services and to enhance the management of public resources. This can include a wide range of applications, such as using data analytics to optimize resource allocation, implementing electronic payment systems to improve financial management, or developing mobile apps to improve citizen access to government services. The goal of GovTech is to improve efficiency, transparency, and accountability in the public sector.

Term	Definition
Interoperability	Interoperability is the ability of different systems, devices, or applications to work together and exchange information. Interoperability is important in PFM because it allows different government agencies or departments to share data and systems in a way that is seamless and efficient. This can help to improve the accuracy and timeliness of financial information and can make it easier for governments to track and manage their resources. It can also help to reduce the costs associated with maintaining separate systems and can improve the overall efficiency of government operations.
Machine learning	Machine learning is a field of AI that involves the development of algorithms and systems that can learn and adapt from data, without being explicitly programmed. Machine learning algorithms are designed to identify patterns and relationships in data, and to make predictions or decisions based on these patterns.
Metadata	Metadata is data that provides information about other data, such as the source of the data, the date it was collected, or the format in which it is stored.
Natural language processing (NLP)	NLP is a field of AI that focuses on the interaction between computers and humans through the use of natural language. It involves the development of algorithms and systems that can understand, interpret, and generate human language, and can be used to process and analyze large amounts of text and speech data. In the context of PFM, NLP can be used to automate tasks such as data entry, data validation, and document analysis, which can help to improve the efficiency and accuracy of financial processes. It can also be used to develop chatbots or other language-based interfaces that can help citizens access government services or information more easily.
Nowcasting	Nowcasting is a forecasting method that is used to predict the current or near-term value of a time series, such as a financial indicator or economic variable. It is based on the idea that the most recent data points in a time series contain the most relevant information for predicting the current or near-term value of the series. Nowcasting can be used in PFM to help governments anticipate short-term changes in their financial performance or in the broader economic environment, and to adjust their policies or strategies accordingly. It can also be used to help governments manage their resources more effectively by providing timely information about changes in revenue, expenditure, or other key financial variables.
Once-only principle	The once-only principle is a concept that refers to the idea that information should be collected and recorded only once and should then be used and shared as needed by multiple organizations or systems. It can be implemented in a variety of ways, such as through the use of shared databases or APIs that allow different systems to access and use the same information, or through the development of common data standards and protocols that facilitate the sharing of information between different organizations. The once-only principle can help reduce the burden on individuals and organizations of having to provide the same information multiple times, and to improve the efficiency and accuracy of information sharing between different systems.
Open data	Open data refers to data that is freely available to be accessed, used, and shared by anyone, subject to certain conditions. Open data is often made available through data portals or other online platforms. In the context of PFM, open data can be used to promote transparency and accountability and may also support the development of new insights and applications.
Open source	Open source refers to a type of software whose source code is available to the public and can be freely accessed, used, and modified by anyone. Open-source software is often more flexible and adaptable to the specific needs and goals of an organization, typically developed and improved by a community of volunteers, and made available under a license that allows users to freely modify and distribute the software.
Open standards	Open standards are technical standards that are developed and maintained openly and transparently and are made available to the public free of charge. Open standards are typically developed through a collaborative process that involves the participation of a wide range of stakeholders, including industry, academia, and government. They can be valuable in ensuring interoperability and compatibility of financial management systems and processes.

Term	Definition
Predictive models	A predictive model is a statistical model that is used to predict the probability or likelihood of an outcome, based on historical data. Predictive models use various techniques, such as regression analysis, decision trees, and machine learning algorithms, to analyze data and make predictions about future events. They can be used in PFM to forecast future trends in revenue and expenditure, identify potential risks and opportunities, and inform decision making.
Product owner	A product owner is a role within the context of agile software development that involves managing the development and delivery of a product. The product owner is responsible for defining the features and requirements of the product, prioritizing the development backlog, and communicating with the development team and stakeholders. Product owners in PFM may work closely with policymakers to ensure that the products align with the organization's objectives and needs.
Reusability	Reusability refers to the ability of a piece of software, data, or other resource to be used multiple times for different purposes. In the context of PFM, reusability could refer to the ability of a financial management system or tool to be used by multiple departments or programs, or to be used to support different types of financial management processes.
Robotic process automation	Robotic process automation is a technology that allows organizations to automate repetitive tasks and processes by using software robots or "bots" to mimic the actions of a human worker. Robotic process automation can be used to automate a wide range of tasks, including processing invoices, generating financial reports, and other repetitive and time-consuming tasks in PFM.
Self-healing architecture	Self-healing architecture is a system that can automatically detect that it is not working correctly and make necessary changes to restore itself to a normal state without any human intervention. The maturity level of a self-healing architecture can vary depending on the extent of its implementation and the sophistication of the self-healing mechanisms in place.
Smart contracts	Smart contracts are self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of code. The code and the agreements contained therein are stored and replicated on a blockchain network. Smart contracts can be used in the public sector to automate relevant processes, reduce the risk of fraud or errors, and create transparent and auditable financial management systems.
Software as a service (SaaS)	SaaS is a model of software delivery in which a software application is hosted by a third-party cloud provider and made available to customers over the internet. SaaS applications are typically accessed through a web browser, and users do not need to install or maintain the software on their own computers. SaaS can be a cost-effective and efficient option for digitalizing PFM, as it typically requires little upfront investment and can be accessed from anywhere with an internet connection.
Structured data	Structured data is data that is organized in a defined format, such as a database or spreadsheet. Structured data is typically easy to process and analyze, as it is organized in a predictable and standardized way.
Test environment	A test environment is a dedicated and controlled setup or infrastructure where software applications, systems, or process changes are tested and validated before being deployed into the production environment. It is designed to closely resemble the production environment, allowing testers to evaluate the functionality, performance, and reliability of the software or system in a safe and isolated environment to ensure that any changes or updates do not negatively effect the live system.
Unstructured data	Unstructured data is data that does not have a defined format and is therefore more difficult to process and analyze. Unstructured data can include things like emails and documents and does not have a predetermined structure or organization.

Term	Definition
Waterfall approach	The waterfall approach is a linear method of software development that involves completing one phase of the project before moving on to the next. The phases of the waterfall approach typically include requirements gathering and analysis, design, implementation, testing, and deployment. The waterfall approach has the advantage of being well-defined and easy to understand, with clear objectives and deliverables for each phase. However, it can be inflexible, as it does not allow for much iteration or adjustment once a phase has been completed. Compare to "agile approach," also included in this glossary.
Zero trust architecture	Zero trust architecture is a security model that assumes that all users, devices, and networks inside and outside of an organization's perimeter are potentially untrustworthy and must be verified before they are granted access to resources. In this model, access to resources is granted based on the user's identity, the device they are using, and the context of the request, rather than on the location of the user or device.

Source: ChatGPT (fine-tuned by authors), unless otherwise noted.

PUBLICATIONS

Digital Solutions Guidelines for Public Financial Management

TNM/2023/07

ISBN 979-8-40-025156-6