

Cambridge
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UNIVERSITY OF
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Judge Business School

CAMBRIDGE SUPTECH LAB STATE OF SUPTECH REPORT 2023



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ABOUT THE CAMBRIDGE SUPTECH LAB

The Cambridge SupTech Lab accelerates the digital transformation of financial supervision to foster resilient, transparent, accountable, sustainable, and inclusive financial sectors.

The Lab catalyses the integration of innovative technologies and data science into supervisory processes to meet both enduring and emerging challenges in the rapidly changing financial landscape. Through the Lab, financial authorities have championed the adoption of advanced suptech solutions to address pressing issues such as financial crime, fraud, exclusion, climate change enablers, consumer protection, and artificial intelligence biases.

Our global, multidisciplinary team has partnered with financial authorities' executives, supervisors, and data scientists to craft solutions throughout the entire innovation lifecycle, from data governance to AI-powered strategies, from the drawing board to full-scale deployment and expansion of cutting-edge suptech applications.

The Lab is an initiative of the Cambridge Centre for Alternative Finance (CCAF) at the University of Cambridge Judge Business School.

We invite you to find out more at

www.cambridgesuptechlab.org



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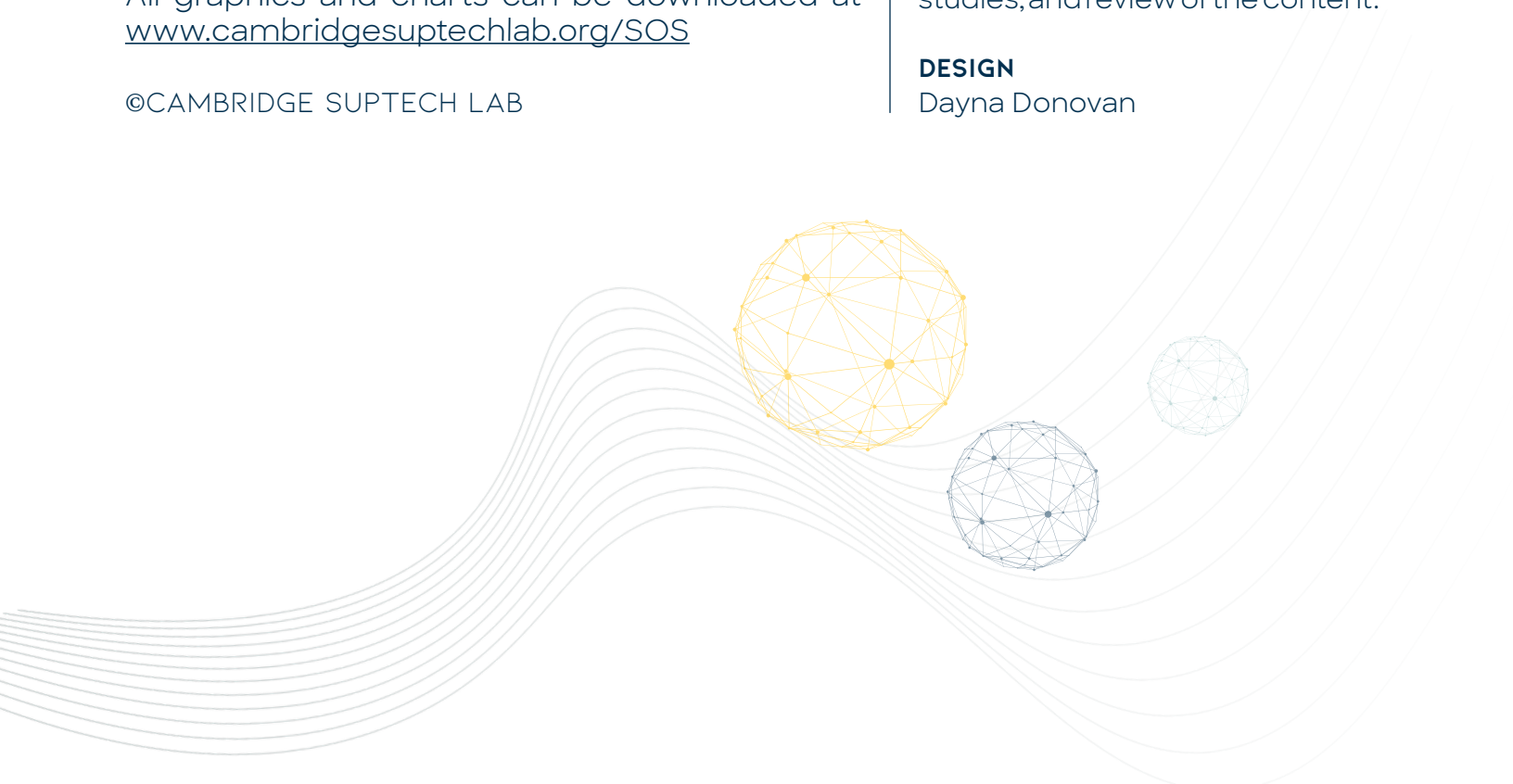
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EXECUTIVE SUMMARY



THE CAMBRIDGE SUPTECH LAB STATE OF SUPTECH REPORT 2023 PRESENTS INSIGHTS ON THE EVOLUTION OF THE DIGITAL TRANSFORMATION OF FINANCIAL SUPERVISION WORLDWIDE.

The Report provides a global snapshot across several facets of supervisory technology (suptech), including underpinning digital infrastructure and technologies, supported supervisory use cases, approaches employed for developing and deploying suptech applications, and the related challenges and risks. It also presents year-to-year analysis using data from the [State of SupTech Survey 2022](#).

The State of SupTech Report 2023 focuses on how the development and implementation of suptech is evolving across the globe, extracting insights from the information provided by 64 financial authorities such as central banks, securities and capital market authorities, financial conduct authorities, and insurance supervisors from six continents.

This year's survey leverages the 2022 Report as a baseline to provide a picture of emerging trends, persisting and new challenges, maturing strategies, and attained impacts. Compared to last year, the 2023 survey included five times more questions, allowing for a substantially more detailed and expansive analysis, with the trade-off of having a smaller sample size of respondents.

HIGHLIGHTS FROM THE STATE OF SUPTECH REPORT 2023

- **The positive trend in the adoption of suptech continues.** 81% of surveyed financial authorities indicate their involvement in various suptech initiatives, an increase from the 71% reported last year. Additionally, 59% of financial authorities now confirm the utilisation of one or more suptech applications, marking modest growth from the 54% reported in the previous year. Notably, there is an expanding disparity (25%) in suptech adoption rates between authorities in advanced economies (AEs) (79%) and those in emerging market and developing economies (EMDEs) (54%) compared with 2022, when 50% of financial authorities from AEs had deployed one or more suptech applications, compared to 31% from EMDEs, a gap of 19%.
- **Financial authorities are at first- and second-generation stages in the adoption of a complete suptech digital infrastructure.** Foundational technologies from early generations such as descriptive analytics (83%), dashboards, on-premise relational databases, and web portals (79%) and static reports (73.6%) persist in bolstering data quality, management, and overall efficiency in supervisory processes.
- **The adoption of emerging, next-generation technologies, particularly generative artificial intelligence (GenAI), by financial authorities is slowly advancing but met with a range of challenges.** 7.6% of respondents reported the incorporation of Generative AI (GenAI) technology to support suptech. Among the 35% of respondents utilising AI for supervisory processes, a predominant issue is the intricate nature of training, validation, and testing procedures to ensure the resilience and robustness of AI models in handling complex financial tasks. Additionally, data privacy and protection and poor data quality are identified as significant obstacles.
- **The diversity in approaches to designing these applications, particularly the prominence of human-centred design philosophies, reflects a commitment to intuitive and effective tools that cater to the nuanced needs of end-users, especially supervisors.** Agile methodologies, including the adoption of strategies like producing or procuring Minimum Viable Products (MVPs), play a pivotal role for financial authorities, with 50% implementing such approaches to swiftly address critical needs, encompassing iterative activities such as conducting diagnostics (64%) to inform system requirements and developing working prototypes (68.2%) for real-time feedback and refinement.
- **While 59% of financial authorities currently utilise one or more suptech applications, merely 9% have formulated a comprehensive suptech strategy or roadmap.** However, investments and progress are being made toward a more comprehensive approach that includes a cultural transformation through governance, skilled resources and interdisciplinary collaboration.
- **Leadership roles for suptech are being established.** 54% of the respondents have created new positions to lead digital transformation and suptech. Additionally, 48.2% of the financial authorities report that they strategically organise their data science capabilities primarily through dedicated roles within supervisory

areas, recognising the pivotal role that data plays in supervisory functions.

- **Financial authorities cite challenges arising from a lack of adequately trained personnel** possessing essential IT skills (69%) and data science capabilities (73%). To upskill staff, 63% of respondents have instituted training programs, and 48% of financial authorities have proactively begun capacity-building initiatives.
- **Financial authorities have also engaged and collaborated with the broader suptech ecosystem** by participating in and even hosting forums for peer learning and knowledge exchange (51%), and undertaking partnerships between regulatory bodies, regulated entities, and technology service providers within jurisdictions (47%).
- **The focus on using suptech solutions for prudential banking and protecting consumers from unfair, abusive and illegal practices remains steadfast.** Prudential banking (69%), consumer protection and market conduct (62%), anti-money laundering/counter-terrorism financing and proliferation (AML/CFT/CPF) (59%), and cyber risk supervision (39.3%) persist as the primary areas of focus for suptech applications.
- **There is work to be done in leveraging suptech to build a more gender-inclusive financial system.** Fewer than 50% of financial authorities actively collect comprehensive sex-disaggregated data. The primary focus of sex-disaggregated data collected by financial authorities revolves prominently around demographic data (91.7%). To gain more nuanced insights into gender-specific challenges, financial authorities should prioritise comprehensive data collection that

includes transactional, financial, and operational data.

- **Financial authorities are recognising the increasing importance of Environmental, Social, and Governance (ESG) factors,** with 32% incorporating oversight mechanisms to address associated risks and align financial activities with broader sustainability goals.
- **Respondents cite numerous benefits after adopting suptech.** A significant advantage is the acceleration of supervisory action (76%), facilitated by suptech tools enabling swift analysis and response to emerging risks. More efficient information flows between consumers and supervisors (65%) enables supervisors to collect and analyse information from financial market participants more effectively, promoting transparency and ensuring a timely response to potential issues. Furthermore, these initiatives have a positive impact on consumer outcomes (52%), leading to improved protection and increased confidence in financial markets.



1. **INTRODUCTION** 2023 IN REVIEW

1.1. Suptech is a journey, not an event.

The accelerated integration of technology into supervisory practices marks a paradigm shift in the financial sector, enhancing supervisory agencies' efficiency and effectiveness, furthering risk mitigation across the ecosystem, and improving compliance while reducing its costs.

[The State of SupTech Report 2022](#) included a comprehensive timeline of the digital transformation of financial supervision. This historical account begins in the aftermath of the Black Monday market crash of 1987, a pivotal event that underscored the need for more robust financial oversight mechanisms and set the stage for the initial forays into what would become known as supervisory technology (suptech). From these nascent beginnings, the timeline extends through various financial milestones and technological advancements that have shaped supervisory practices.

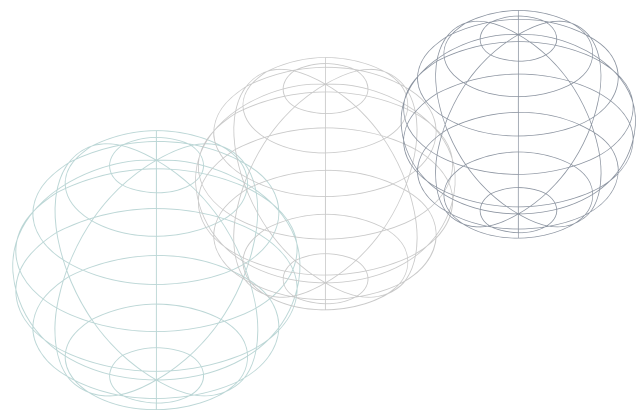
The report highlights key moments where the financial sector faced systemic shocks and regulatory challenges, from the Asian financial crisis in the late 1990s to the global financial crisis of 2007–2008, each serving as a catalyst for innovation in regulatory oversight and the gradual integration of technology into these processes. The emergence of big data analytics, cloud computing, and artificial intelligence in the 2010s marked the beginning of a new era in suptech, providing supervisors with unprecedented capabilities to monitor, analyse, and respond to market developments.

The COVID-19 pandemic served as an unexpected accelerant for suptech adoption. The rapid digitisation of financial activities and the associated risks, coupled with the need for remote working arrangements, prompted

supervisory agencies worldwide to adopt advanced technologies more quickly than ever before. This period witnessed a significant uptick in the deployment of cloud-based platforms, machine learning algorithms, and automated compliance tools to ensure continuous and effective financial oversight despite the disruption caused by the pandemic.

Yet, as the Report noted, the history of suptech is not static; it is an ongoing saga of adaptation and progress. Even beyond the pandemic, the suptech landscape continues to evolve, driven by continuous innovation in the financial sector, emerging risks, and the relentless pace of technological change. The ongoing development of blockchain, the rise of decentralised finance (DeFi), and the advent of quantum computing are just a few of the frontiers that promise to redefine the capabilities and strategies of financial supervisors in the years to come.

As we look to the future, we can expect suptech to play an increasingly central role in shaping the efficiency, resilience, and fairness of the global financial system. New challenges and opportunities will undoubtedly emerge, demanding that supervisors remain vigilant and forward-thinking in their adoption and utilisation of supervisory technologies. As we noted in the State of SupTech Report 2022, “suptech is a journey, not an event.”



1.2. 2023: Suptech advancements in a volatile year

2023 was another vibrant chapter of the unfolding story of how technology and data science continue to transform financial supervision in ways we have yet to fully imagine.

In 2023, the global financial sector witnessed a confluence of economic pressures that tested the resilience of its institutions and the capabilities of its regulators and supervisors. Persisting inflation, despite the tightening of monetary policy in many of the world's largest economies, led to a challenging combination of slower growth and higher interest rates. These [macroeconomic shifts](#) resulted in tighter credit conditions, constrained access to funding, and put new strains on existing business models. Core inflation and the associated rising rates emerged as primary [credit risks](#), painting a picture of a financial landscape navigating through turbulent waters. Tighter monetary policies implemented to combat inflation had significant side effects, including increased economic inequality and impacted investment prospects.

Amidst these broad economic challenges, the banking sector faced its own share of specific trials. The startling collapses of [Silicon Valley Bank](#) and [Signature Bank](#) in the United States marked a significant chapter in the narrative of banking vulnerabilities, as these institutions transitioned out of an era of low-interest rates. Their downfall signified the [most significant system-wide banking stress](#) witnessed since the Great Financial Crisis, both in terms of scale – with a [combined \\$548.7 billion of assets affected](#) – and scope, outpacing previous crises in both 1984 and 2008. In the aftermath, other institutions, including

the historic First Republic Bank and the innovative Silvergate Bank, faced their own challenges, with the latter opting for voluntary self-liquidation. These events underscored the interconnected nature of modern banking, where the demise of a few key players had profound implications for a multitude of others, leading to [special assessments](#) to compensate for a significant shortfall in the Deposit Insurance Fund.

This tumult in the banking sector served as a global wake-up call, prompting supervisory authorities to [scrutinize and strengthen their supervisory review](#) processes. It was a stark reminder of the complexity and rapid evolution of the banking landscape, which now includes a proliferation of crypto-related activities and an array of new digital financial services. The need for a robust framework that could effectively oversee [both systemic and non-systemic banks](#) became clear.

Supervisory authorities have been strengthening their capabilities to face this challenging environment, while simultaneously catching up with the latest market trends. Thus, several noteworthy initiatives have emerged in 2023.

For instance, the Monetary Authority of Singapore (MAS) set a precedent with [Project MindForge](#), crafting a risk framework specifically designed to address the intricacies of Generative Artificial Intelligence (GenAI) within the financial sector. The Financial Services Regulatory Authority (FSRA) of Abu Dhabi Global Market (ADGM) [partnered](#) with the Mohamed bin Zayed University of Artificial Intelligence (MBZUAI) in a strategic move to foster innovation in regulatory compliance through artificial intelligence. MAS also launched [Gprint](#), an ambitious digital platform that harnessed technology to streamline the collection and usage of environmental, social, and governance (ESG) data, empowering the

financial sector's sustainability initiatives.

Other suptech advancements included the Korean Financial Supervisory Service's adoption of an [AI tool](#) to detect mis-selling in insurance telemarketing, the Central Bank of Malaysia's development of a supervisory [letter-writing aid](#) powered by natural language processing and machine learning, and the European Central Bank (ECB) deployed [Athena](#), a new natural language processing (NLP) AI tool that allows over 1,000 supervisors to analyse more than 5 million documents across the Single Supervisory Mechanism (SSM). In Germany, the Central Bank began [experimenting](#) with OpenAI technology to develop a knowledge assistant product, while in the Philippines, the Central Bank successfully completed a five-year project [originated](#) with the RegTech for Regulators Accelerator (R2A) to migrate all financial institutions' regulatory reports to APIs – a case study in modernisation and efficiency.

These developments were not limited to individual national initiatives. On the international stage, standard-setting bodies like the International Organization of Securities Commissions (IOSCO) set out global crypto regulation [standards](#), while the Financial Stability Board (FSB) published a [framework](#) for crypto-asset activities to ensure a cohesive and consistent regulatory approach worldwide. [Project Leap](#) saw the Bank for International Settlements (BIS) collaborate with the Banque de France and Deutsche Bundesbank to establish a quantum-safe communication channel, securing financial data against emerging cyber threats – a move reflective of the heightened importance of cybersecurity in an increasingly digital financial ecosystem.

The International Monetary Fund (IMF) demonstrated the power of data analytics by employing text analysis techniques to create a [financial stress index](#) for

over a hundred countries, opening new avenues for understanding the cycles of booms and busts in the global economy. Such analytical tools are becoming indispensable in the face of the complex financial phenomena of the 21st century. Additionally, the Network for Greening the Financial System (NGFS) released a [conceptual framework](#) to help central banks and supervisors address nature-related financial risks.

This year also marked a mainstreaming of alternative data formats for use in financial supervision. Building on last year's [experiments](#), financial authorities are increasingly complementing traditional compliance data collection with less-structured, alternative data. Text extraction from scanned PDFs, topic modeling of complaints, social media posts and app store reviews, and natural language querying of supervisory documents and data have now arrived on the scene.

The BIS Irving Fisher Committee hosted its annual workshop on [data science in central banking](#), highlighting many more advanced, innovative suptech applications from financial authorities around the world.

This has been accelerated by an influx into the suptech realm of large language models (e.g., OpenAI's [GPT](#), Google's [Gemini](#), Meta's open-source [Llama](#)) and corresponding Generative AI technologies (e.g., [ChatGPT](#), [Bard](#), open-source [Langchain](#)). These tools have introduced a combination of significant excitement and genuine promise, accompanied by a range of emerging and increasingly significant risks.

Simultaneously, in part as a direct effort to curb such risks, accountability for AI systems has taken great strides. Algorithmic fairness, differential privacy, and data protection regulations are likewise entering the mainstream. Canada became one of the world's first countries

to propose a law to regulate AI with their [Artificial Intelligence and Data Act](#). The United States introduced the [Algorithmic Accountability Act](#). And of course, the EU's Council and Parliament struck a deal on "the first rules for AI in the world" with their [Artificial Intelligence Act](#).

Like the AI systems they intend to regulate, these regulations will have implications well beyond the tech industry. The effects of each are sure to become pervasive in many aspects of the public's daily lives, including the financial sector. In particular, the later-generation suptech solutions will necessarily have to account for this [shifting landscape](#).

We encourage you to explore section 4, which presents comprehensive case studies showcasing the extensive range and depth of suptech innovation occurring worldwide.

1.3. Advancements in the suptech ecosystem: Contributions by the Cambridge SupTech Lab

In 2023, the Cambridge SupTech Lab's [capacity building and education programs](#) witnessed the graduation of 254 managers, supervisors, and data specialists from 40 financial authorities. These professionals were equipped with unparalleled access to pioneering research, innovative analytical frameworks, and insights into the latest suptech applications. The curriculum included hands-on data science practicums, use of a digital collaborative platform, and digital tools essential for crafting original proof of concept (POCs), as well as developing comprehensive strategies and roadmaps.

Graduates emerged from the program with the expertise necessary to navigate

the ongoing market innovations and better understand the customer digital journey, harnessing the power of data science. They received in-depth training in techniques for creating data-driven and user-centric solution designs, implementing effective change management, and leading digital transformation initiatives across their agencies.

The participants have developed 86 new POCs for innovative suptech applications. Five of those POCs were [prototyped](#) in the second half of 2023 with Bangko Sentral ng Pilipinas (BSP), the Philippines Securities and Exchange Commission (SEC), the Superintendencia de Banca, Seguros y AFP (SBS) of Peru, the Indonesian Otoritas Jasa Keuangan (Financial Services Authority) (OJK), the Bank of Ghana (BOG), and vendors Proto, Winnow Technologies, and FNA, focusing on the augmentation of consumer protection supervision via chatbots, complaints management systems, and web and social media scrapers. [See section 4.1.](#)

Partnering with the Alliance for Innovative Regulation (AIR), the Lab also held a virtual suptech [hackathon](#) to further the use of consumer complaints and other supervisory data for consumer protection supervision.

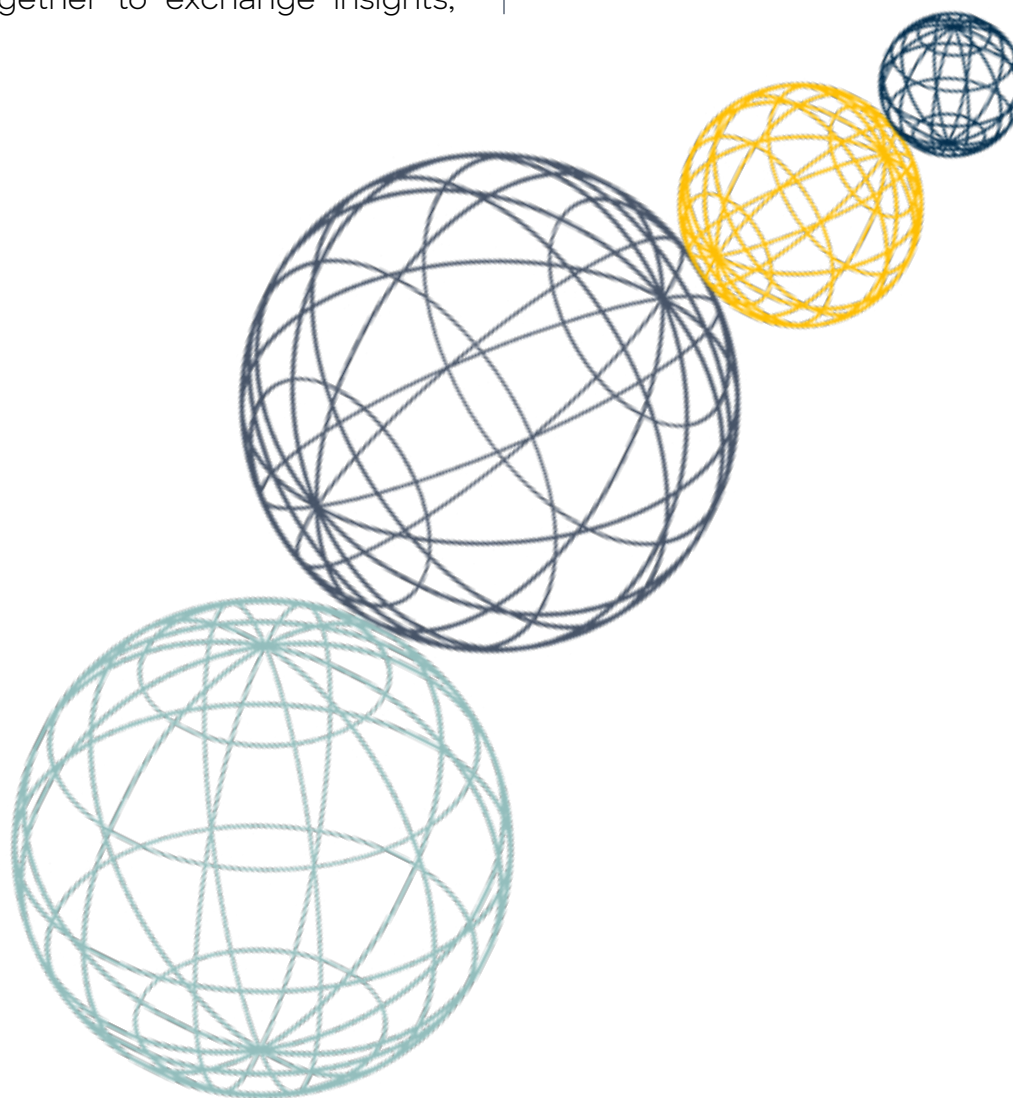
The Lab's initiatives are supported by digital tools designed to bolster the capabilities of financial authorities, foster collaboration, and reduce costs associated with innovation. These digital tools are tested and refined through technical assistance engagements through which the supervisory teams of the financial authorities collaborate with Lab experts to undertake diagnostics, analyse data architectures and tech stacks, and design suptech solutions, strategies, and roadmaps. In 2023, this portfolio included work with Banco de la República of Colombia on foreign exchange transactions monitoring, with

the Superintendencia de Economía Popular y Solidaria (SEPS) of Ecuador on the deployment of a chatbot for consumer protection supervision and financial education, with the Central Bank of Egypt (CBE) on financial consumer protection supervision and data analytics, with Bank of Moldova on overall suptech-powered transformation of their supervisory capabilities, with the Superintendencia de Banca y Seguros del Perú (SBS) on strengthening the supervising model of market conduct management, and with Bank of Uganda on rearchitecting prudential supervision via tech and data science.

The year concluded with the gathering of over 600 leading experts across the ecosystem of financial supervision, coming together to exchange insights,

innovations and research on the digital transformation of financial supervision at the inaugural online [SupTech Week](#). This first annual, week-long forum was hosted by the Lab in partnership with the BIS Innovation Hub and the World Economic Forum.

By dissecting the state of suptech across technologies and supervisory requirements, this second State of SupTech Report provides a holistic view of the transformative journey undertaken by financial authorities to digitally transform financial supervision, fostering a deeper understanding of suptech across the supervisory spectrum.



The background of the page is a dark blue gradient. Overlaid on this are faint, glowing white and yellow circuit-like patterns that resemble a complex network or data flow. In the lower portion of the image, a laptop is visible, with a hand typing on its keyboard. The overall aesthetic is high-tech and digital.

2.

SURVEY SCOPE AND METHODOLOGY

DEFINITIONS, SAMPLE,
SUPTECH TAXONOMY AND
SUPTECH GENERATIONS FRAMEWORK

2.1. Definition of suptech

Suptech is an acronym for ‘supervisory technology’. It encompasses the application of technology and data analysis solutions to augment a financial authority’s capabilities to oversee financial markets and to use supervisory data to enhance market-players’ outcomes.

The suptech journey includes both the digitisation of analog supervisory processes and the creation of “suptech first” methodologies and tools, and the integration of sophisticated tools such as artificial intelligence (AI), machine learning, big data analytics, and blockchain.

We encourage you to refer to Appendix 3 for the definitions of key terms, technologies, and concepts referenced in this Report.

2.2. Survey sample

In a comprehensive exploration of the evolving suptech landscape, the survey delved into six thematic areas:

- 1. Suptech adoption:** The spectrum of suptech initiatives worldwide, shedding light on the diverse approaches and methodologies employed by financial authorities across different economies.
- 2. Suptech use cases:** The multifaceted landscape of suptech integration across diverse supervisory areas. The survey employed the Cambridge SupTech Lab’s SupTech Taxonomy (see section 2.3) to categorise supervisory areas and use cases, providing a structured framework for analysis and understanding.
- 3. Suptech challenges and risks:** The challenges and risks faced by financial authorities during the implementation of suptech initiatives, offering valuable

insights into the potential hurdles and obstacles that warrant attention.

- 4. Suptech enabling factors – Technologies and data science tools in the supervisory stack:** The technologies and data science tools utilised by financial authorities to address challenges and achieve goals within specific supervisory areas, classifying them based on their applications across the six layers of the SupTech Generations 2.0 (see section 2.4).
- 5. Suptech for financial inclusion and gender data:** The role of suptech in fostering financial inclusion and gender data analysis, investigating how it enables effective decision-making and the ability to address challenges faced by marginalised segments, particularly women.

Data presented in this report was collected between August and early November 2023, through a global survey conducted by the Cambridge SupTech Lab. The respondents are financial authorities such as central banks, securities and capital market authorities, financial conduct authorities, and insurance supervisors.

The survey received a total of 64 responses from across the globe.

This year’s survey adopts a strategic departure from the previous year’s approach. The 2023 survey included five times more questions than the 2022 survey, creating a substantially more detailed and expansive instrument. This augmentation is geared toward capturing a deeper perspective on the multifaceted aspects of the suptech landscape. The increased number of questions allows for a nuanced exploration of various dimensions of the financial authorities’ suptech journey, including challenges faced, strategies employed, the evolving culture of innovation and collaboration, and the reengineering of processes

and methodologies for financial supervision that tech and data science are underpinning. The trade-off of this

increased breadth and depth is that this year we have a smaller sample size compared to last year.

FIGURE 1.
DISTRIBUTION OF RESPONDENTS BY INSTITUTION TYPE

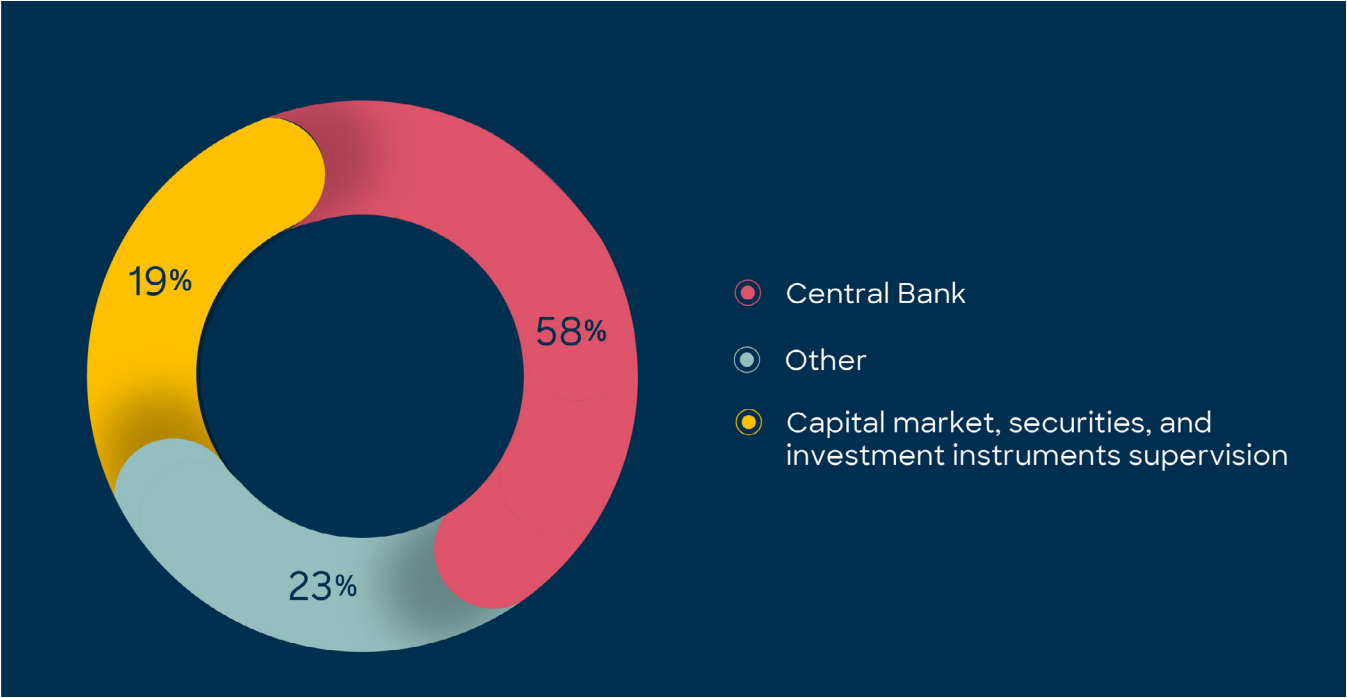


FIGURE 2.
DISTRIBUTION OF RESPONDENTS BY GROSS NATIONAL INCOME PER CAPITA

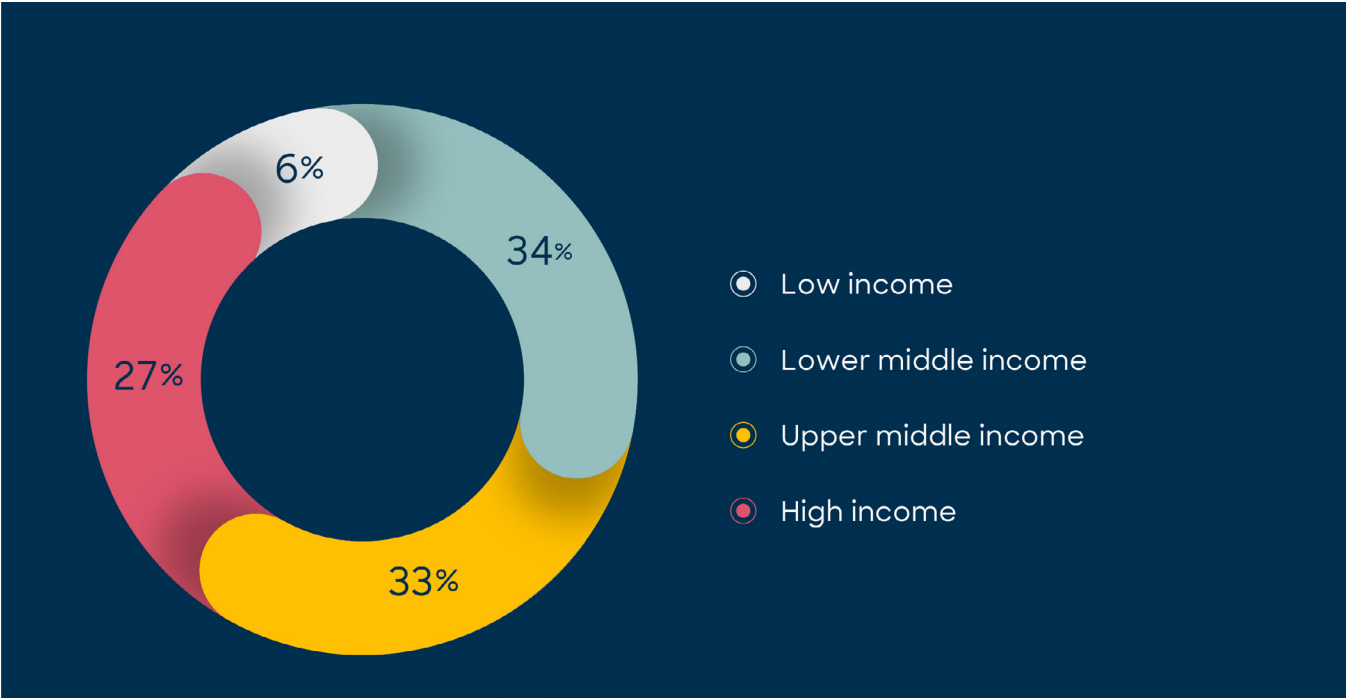
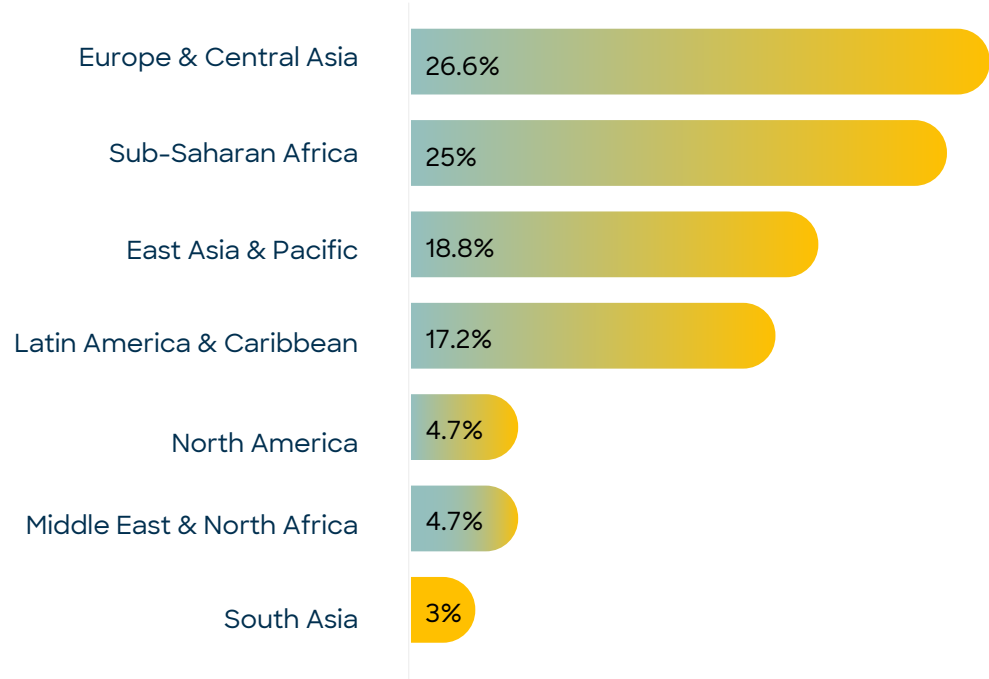


FIGURE 3.
DISTRIBUTION OF
RESPONDENTS BY
REGION



The survey data used for our analysis is treated with the utmost confidentiality and privacy. As such, all examples, illustrations and case studies presented in this Report are drawn exclusively from publicly available data sources rather than from the responses submitted by the agencies.

The survey responses boast a robust and geographically diverse representation of financial authorities from jurisdictions across the globe, representing financial sector oversight for a significant population of approximately 2 billion people.

This ensures that the insights derived from the survey are not only intensive but also representative of a diverse and broad cross-section of the suptech landscape.

Of the 64 respondents, 58% are from central banks, 19% are from capital markets, securities, and investments supervision, and 23% are from other financial authorities. A full breakdown is available in Appendix 1.

73% of the agencies represent Emerging Markets and Developing Economies

(EMDEs). In terms of gross national income per capita, 26.6% of the respondents represent High-Income Countries (HICs), 32.8% Upper-Middle-Income Countries (UMICs) and 41% Lower-Middle-Income Countries (LMICs). Low-Income Countries (LICs) have a minimal presence in the sample (6.3%). This aligns with the slow adoption of suptech solutions in many nations within the lowest income bracket that is evidenced in the [SupTech Solutions Tracker](#), which is populated based on our extensive literature review and desk research conducted over the past two years and reveals a paucity of suptech developments in LICs.

2.3. Suptech taxonomy

The survey adopts a comprehensive classification system that the Lab has deployed across its intelligence and digital tools to consistently organise various entities - namely, suptech vendors, suptech solutions and suptech diagnostics - by supervisory use cases (the ‘sup’ in suptech) and by the technologies and data science tools used (the ‘tech’).

This taxonomy was introduced in the [State of SupTech Report 2022](#). It distinctly categorises the ‘supervisory’ aspects from the ‘technology’ aspects so as to methodically identify the requirements of supervisors, organise the tools that meet these requirements, and ultimately establish a framework for strategically aligning solutions with those needs.

The taxonomy (see Appendix 2) covers 13 broad supervisory categories subdivided into 87 use cases. The structure of the classification system is hierarchical and built on a conceptual framework that groups use cases according to the activities conducted by supervisory functions within authorities.

The technologies and data science tools deployed to address financial authorities’ requirements are classified by their applications within the context of the five layers of a supervisory ‘stack’ The most recent update to this taxonomy is the inclusion of generative AI, which marks the only alteration from the previous year’s version.







2.4. SupTech Generations

The SupTech Generations 2.0 framework serves as an ontology to demonstrate how each technology-enabled element of the supervisory process might evolve through time. Whether through leapfrogging or through incremental transitions, the organisation should gain greater supervisory capabilities than before as it adopts the next generation of technologies, even in the relatively short term.

The framework starts with the automation and improvement of data collection (i.e., transforming from 0G to 1G), progressing to advanced data analysis and visualisation (2G and 3G), moving into predictive modeling and risk assessment using AI and machine learning (3G), and ultimately achieving real-time data analysis and enhanced security through blockchain and distributed ledger technologies (4G).

This framework is an iteration – presented with the State of SupTech Report 2022 – of the one that was [first introduced](#) by the Bank for International Settlements in 2019.

FIGURE 4.
SUPTECH GENERATIONS 2.0 (CAMBRIDGE SUPTECH LAB 2022)

	OG MANUAL	1G MINIMAL TECH	2G DIGITALLY TRANSFORMED	3G ADVANCED TECH	4G BIG DATA & AI
 DATA PRODUCTS	Minimal statistical summaries	Static report generation	Automated dashboards	Dynamic and interactive visualizations	AI-augmented business intelligence tools
 ANALYTICS	No additional analysis	Manual analysis only	Descriptive/Diagnostic Analytics tools	Predictive analytics tools	Prescriptive analytics tools
 ACCESS CONTROLS	Individual access only	Team access only	Department access only	Limited agency-wide access	Agency-wide access
 STORAGE	Physical media	Centralized file-based storage	On-Premise Relational Databases	Cloud computing Database systems	Big Data tools
 VALIDATION + PROCESSING	Manual or no validation rules after receipt of data	Automated validation errors and warnings integrated into data submission process	Static Task Automation	Robotic Process Automation (RPA)	Advanced Data Processing
 COLLECTION	Manually Submitted	Web portal or File Server	Push API	Pull API or Data Commons	AI-based collection or alternative data sources

3.1. Suptech adoption

The adoption of suptech to modernise financial supervision and the overall governance of the financial sector is a global phenomenon that is reshaping the operations of financial authorities as well as their cultures. This section delves into the expansive realm of suptech adoption, providing granular insights into how financial authorities around the world are incorporating technological advancements and data science to enhance their supervisory processes.

81% of the financial authorities surveyed indicated that they have already engaged in different suptech efforts, an increase over the 71% that responded in the affirmative in 2022.

Suptech adoption is typically not via one monolithic system, but rather a set composed of multiple applications. 40% of the respondents have already deployed one or more suptech applications. 86.5% of them have already two or more suptech applications in operation.

FIGURE 5.
DO YOU HAVE ANY INITIATIVES IN YOUR AGENCY THAT YOU WOULD CONSIDER AS SUPTECH? (N=64)

- Yes, we have a suptech strategy/roadmap operating.
- Yes, we have at least one suptech application in development.
- Yes, we have a suptech strategy/roadmap in development.
- Yes, we we have one or more suptech applications currently operating.
- No, we don't have any of the above.

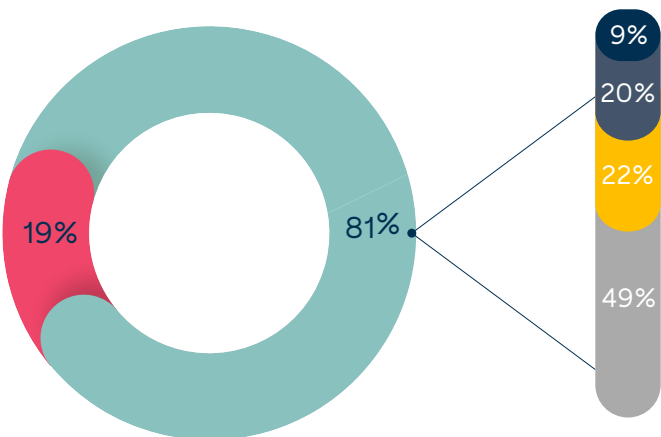


FIGURE 6.
HOW MANY SUPTECH APPLICATIONS DOES YOUR AGENCY HAVE? (N=37)

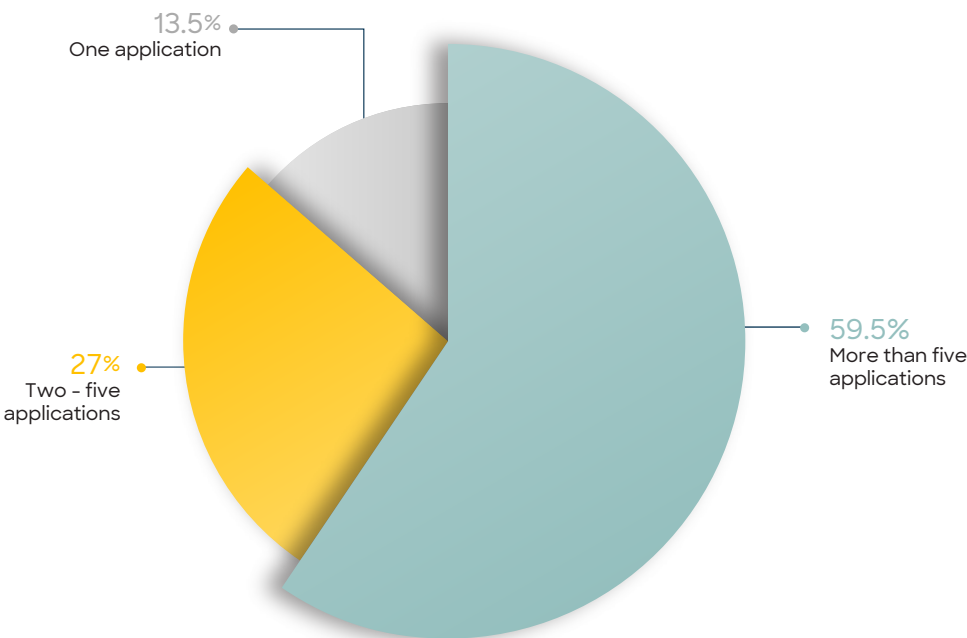
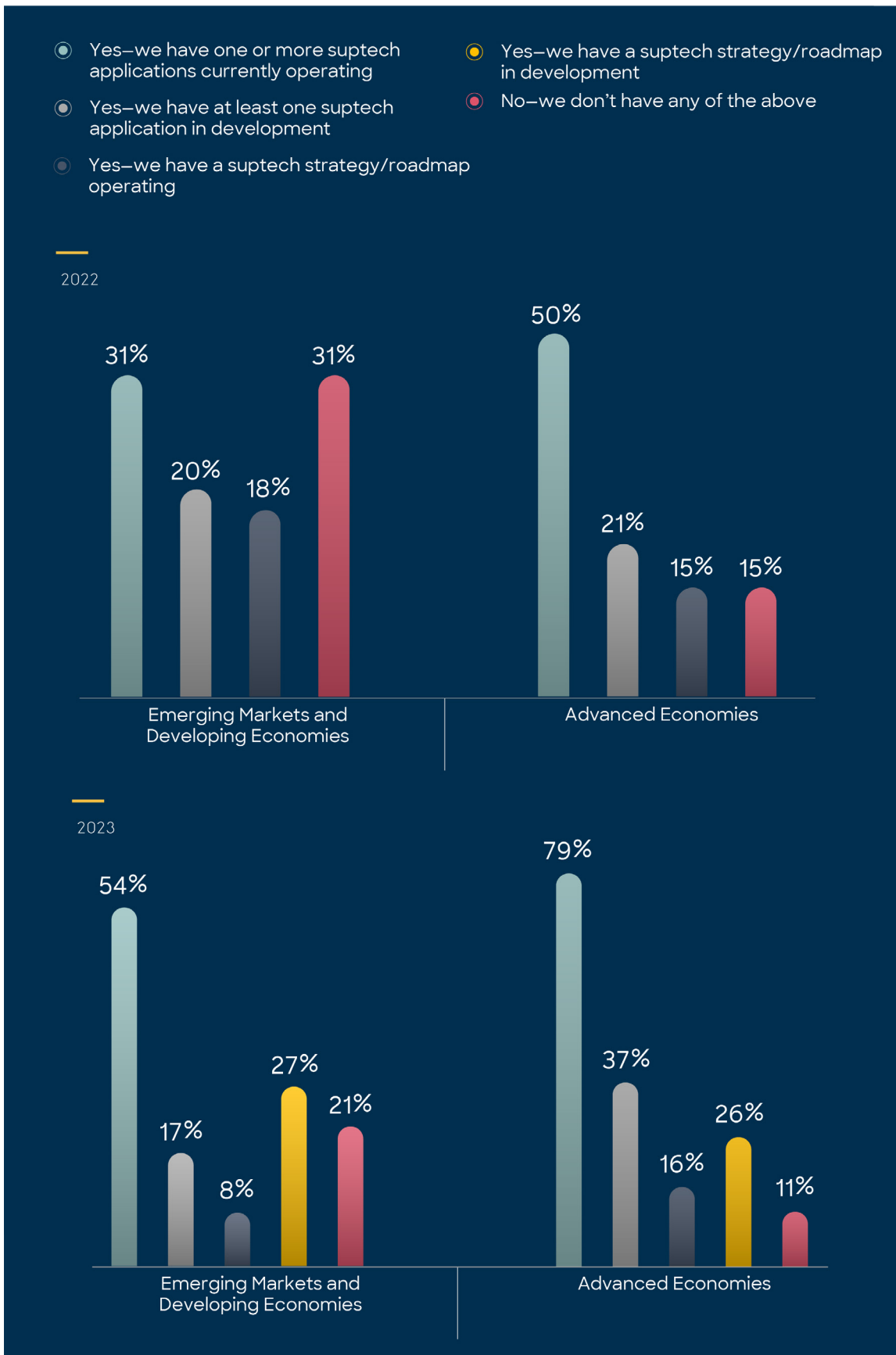


FIGURE 7.
SUPTECH INITIATIVES UNDERTAKEN BY FINANCIAL AUTHORITIES
2022 VS 2023, BY ECONOMIC SEGMENT



Financial authorities in AEs remain at the forefront of suptech adoption.

The vast majority of AE respondents either are already operating one or more suptech applications (79%), and/or are in the process of developing a suptech solution (36.8%). In contrast, financial authorities in EMDEs lag behind their AE counterparts, with only a slight majority using suptech applications (54.2%) and/or have applications in the development phase (16.7%).

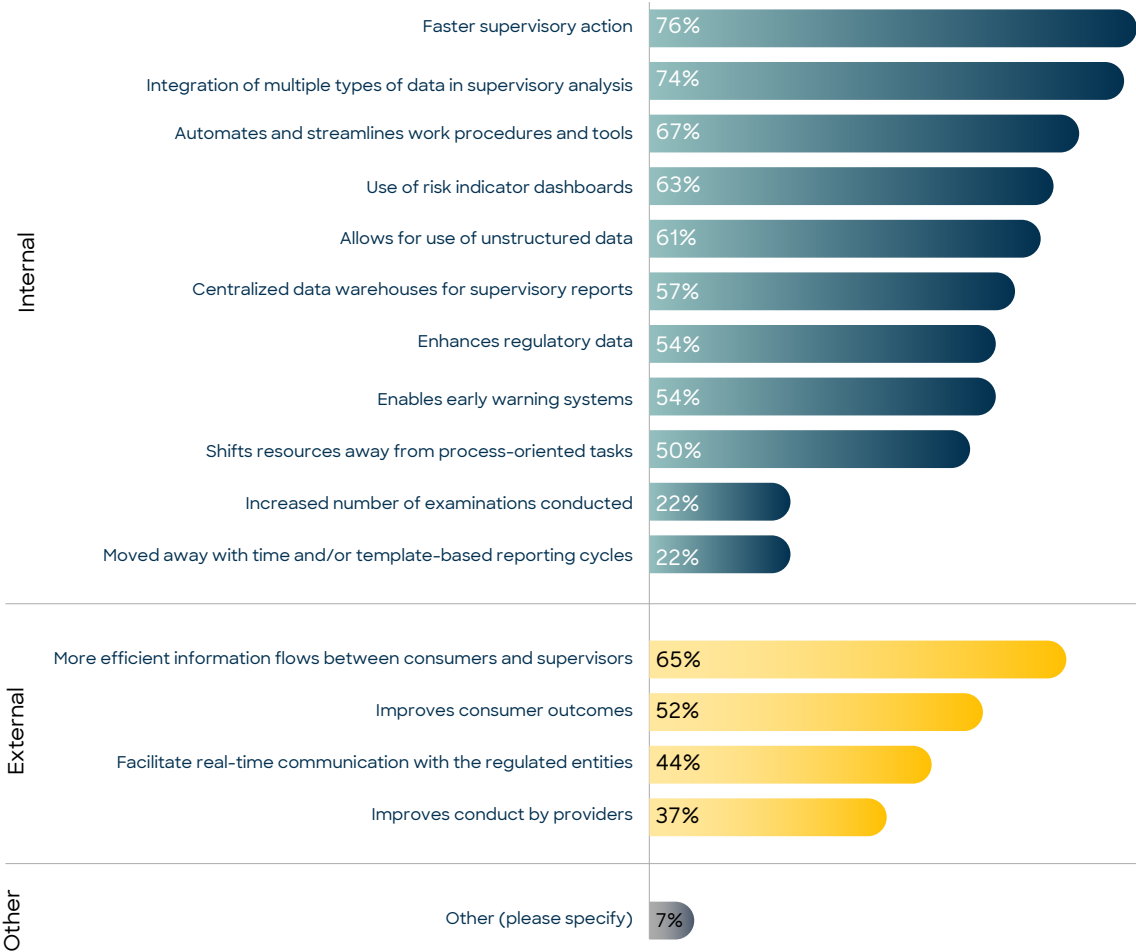
Suptech is advancing in both AEs and EMDEs, however, the gap is widening.

This gap of 25% between AE and EMDE authorities’ active operation of one

or more suptech solutions in 2023 represents an increase over the 2022 gap of 19% (50% of financial authorities from AEs had deployed one or more suptech applications, compared to 31% from EMDEs).

Section 3.6 of this report explores reported challenges and risks that are disproportionately felt by EMDEs, such as operational risks and risks associated with non-representative data, which could account for some of this gap. Section 3.4 and 3.5 explores mechanisms which could serve to alleviate this gap, including data strategies and organisational strategies like training, technical assistance, funding, digital tools, and other forms of support.

FIGURE 8.
HOW DO THE SUPTECH INITIATIVES ENHANCE YOUR SUPERVISORY PROCESS? (N=64)



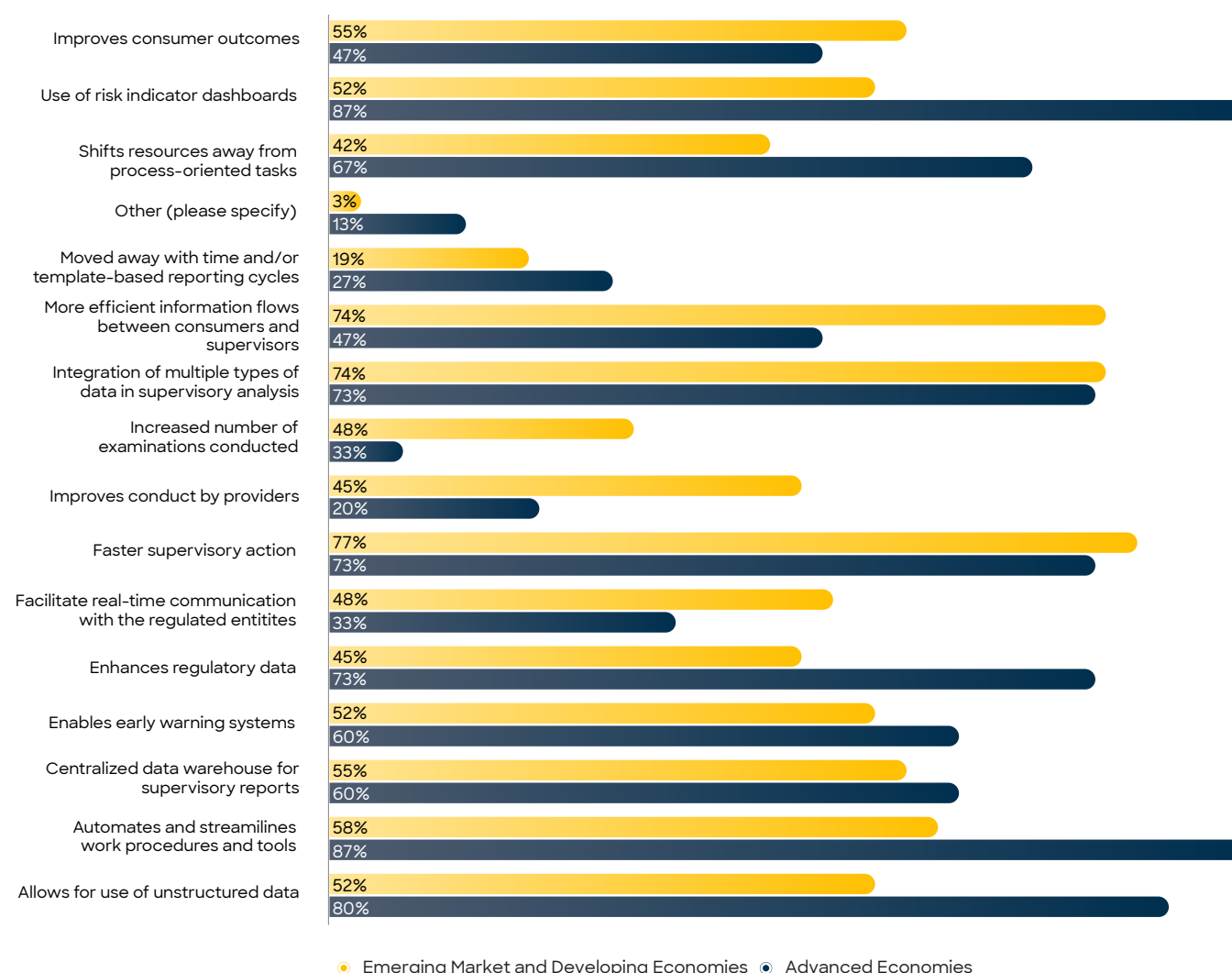
Suptech solutions mostly focus on increased efficiencies – in the form of time and cost savings – that create value for supervisors, supervised entities, and consumers.

Financial authorities recognise that suptech significantly improves supervisory processes, yielding benefits that extend to both internal operations and external engagements with both consumers and financial institutions.

Internally, a significant advantage (76.1%) is the acceleration of supervisory action,

facilitated by suptech tools enabling swift analysis and response to emerging risks. The integration of diverse data types (73.9%) broadens and deepens supervisory analysis, offering a more comprehensive view of the financial landscape. Automation and streamlining of work procedures and tools (67.4%) contribute to operational efficiency by reducing manual efforts and speeding up supervisory tasks. The adoption of risk indicator dashboards (63%) facilitates a timely and proactive approach to risk management.

FIGURE 9.
HOW DO THE SUPTECH INITIATIVES ENHANCE YOUR SUPERVISORY PROCESS? (N=64)
SEGMENTED BY ECONOMIC STATUS



Externally, suptech initiatives foster more efficient information flows between consumers and supervisors (65.2%). This enables supervisors to collect and analyse information from financial market participants more effectively, promoting transparency and ensuring a timely response to potential issues. Furthermore, these initiatives have a positive impact on consumer outcomes (52.2%), leading to improved protection and increased confidence in financial markets.

Authorities in AEs report enhancements in the form of automation and analysis, whereas EMDEs focus on efficiency of processes and underlying data flows.

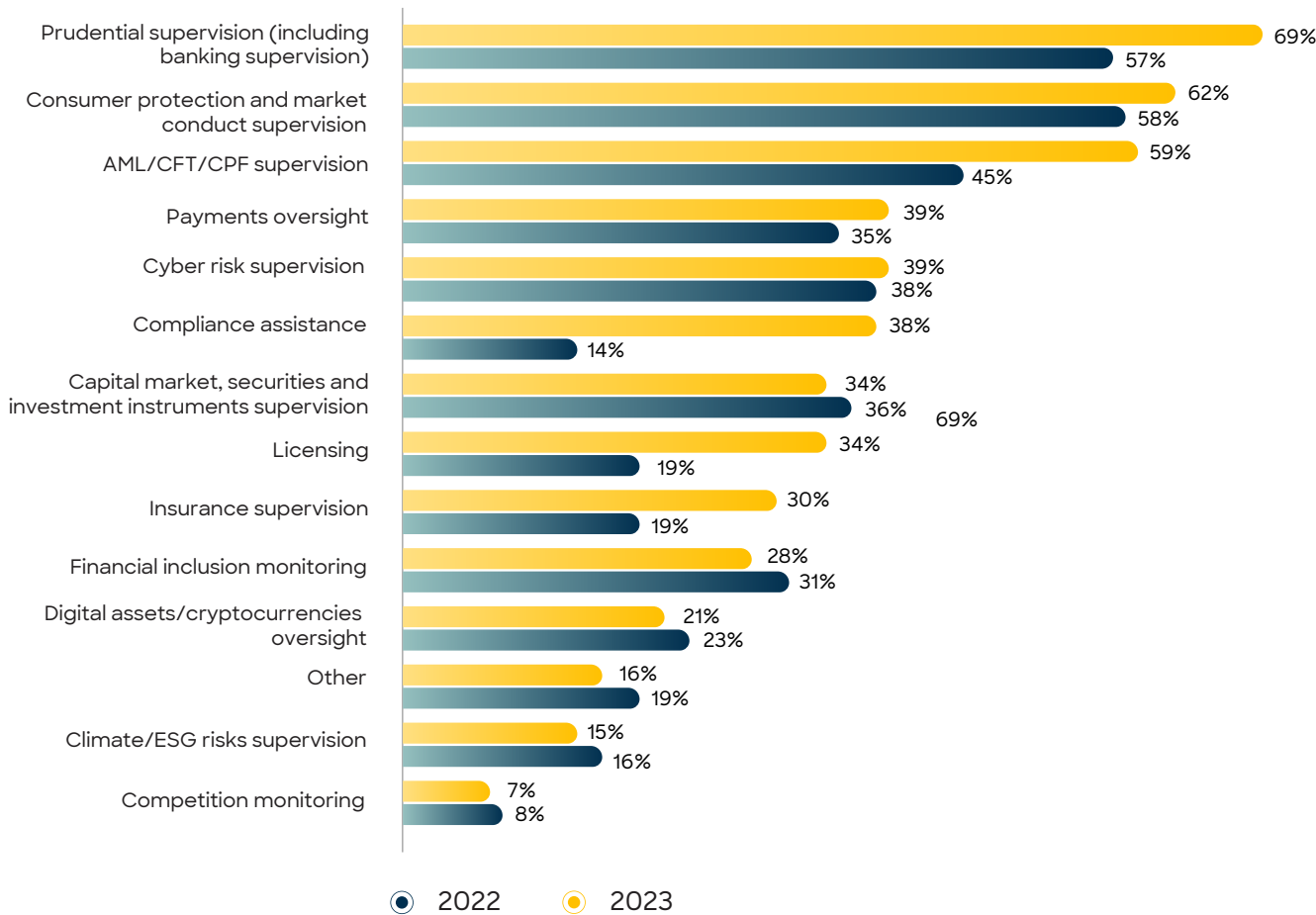
When examining the outcomes of suptech initiatives between AEs and

EMDEs significant differences become apparent. Financial authorities in AEs underscore significant internal achievements, including the automation of work processes (87%), utilisation of risk indicators (87%), and the incorporation of unstructured data (80%).

Conversely, financial authorities in EMDEs highlight outcomes such as expedited supervisory action, integration of various data types (74%), and streamlined information flows with external stakeholders.

Outcomes for EMDEs might fairly be characterised as focused on optimisation of foundational supervisory needs, while outcomes for AEs focus beyond an already-optimised foundation to extend into more advanced areas of research.

FIGURE 10.
WHAT ARE THE OBJECTIVES OF YOUR SUPTECH INITIATIVES?
2022 VS 2023



3.2. Adoption across supervisory areas

Prudential supervision, consumer protection and market conduct supervision, and AML/CFT/CPF remain the top three objectives of supotech solutions.

In terms of the prioritisation, there is minimal deviation from the previous year in the supervisory areas supported by supotech applications. The top three areas – prudential supervision, consumer protection and market conduct supervision, along with anti-money laundering, counter-terrorism financing and counter-proliferation financing (AML/CFT/CPF) – continue to dominate focus. While significant innovation and transformation has occurred on these fronts, such as those highlighted in the case studies sections of both the 2022 and 2023 State of SupTech Reports, there is room for continued investment.

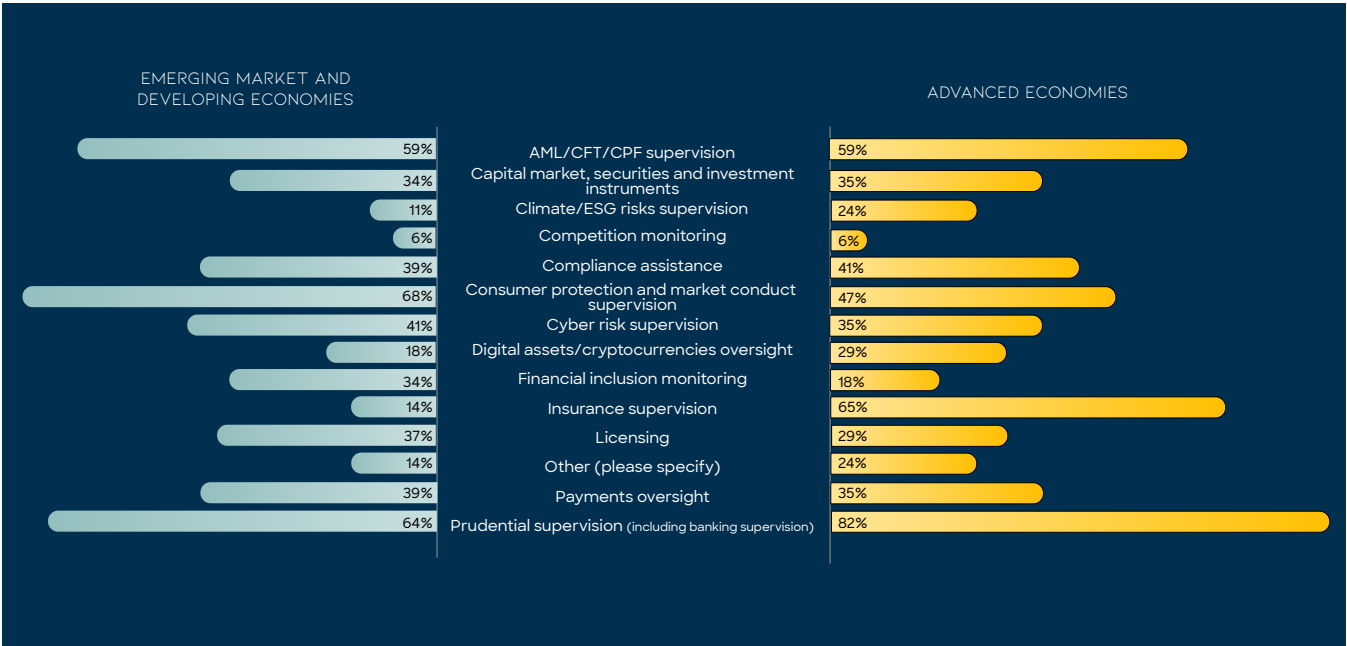
Despite a growing prevalence of digital assets in financial markets, dedicated

supervisory focus remains a lesser priority, particularly for EMDEs.

Surprisingly, digital assets and cryptocurrency oversight is reported to be a priority for only 21% of responding authorities. This is despite a year featuring globally disruptive events in the wake of the [bankruptcy](#) of crypto exchange FTX and subsequent fraud investigations into founder Sam Bankman-Fried and partners, along with other significant [enforcement actions](#) by the US SEC against Binance, Coinbase, Celsius, Kraken, and other major players.

For authorities in EMDEs who report a particularly lower focus than their AE peers (18% versus 29%), this may simply indicate a lag in adopting regulations specific to the supervision of digital assets. For those in AEs, this may indicate that digital assets supervision is being treated in the context within which the digital asset activity is occurring (e.g., assets [passing the Howey test](#) may fall under existing securities supervision, stablecoins may be treated under payment instruments, and on-chain money laundering may

FIGURE 11.
WHAT ARE THE OBJECTIVES OF YOUR SUPTECH APPLICATION(S)? (N=63)
SEGMENTED BY ECONOMIC STATUS



fall within the purview of AML/CFT/CPF supervision).

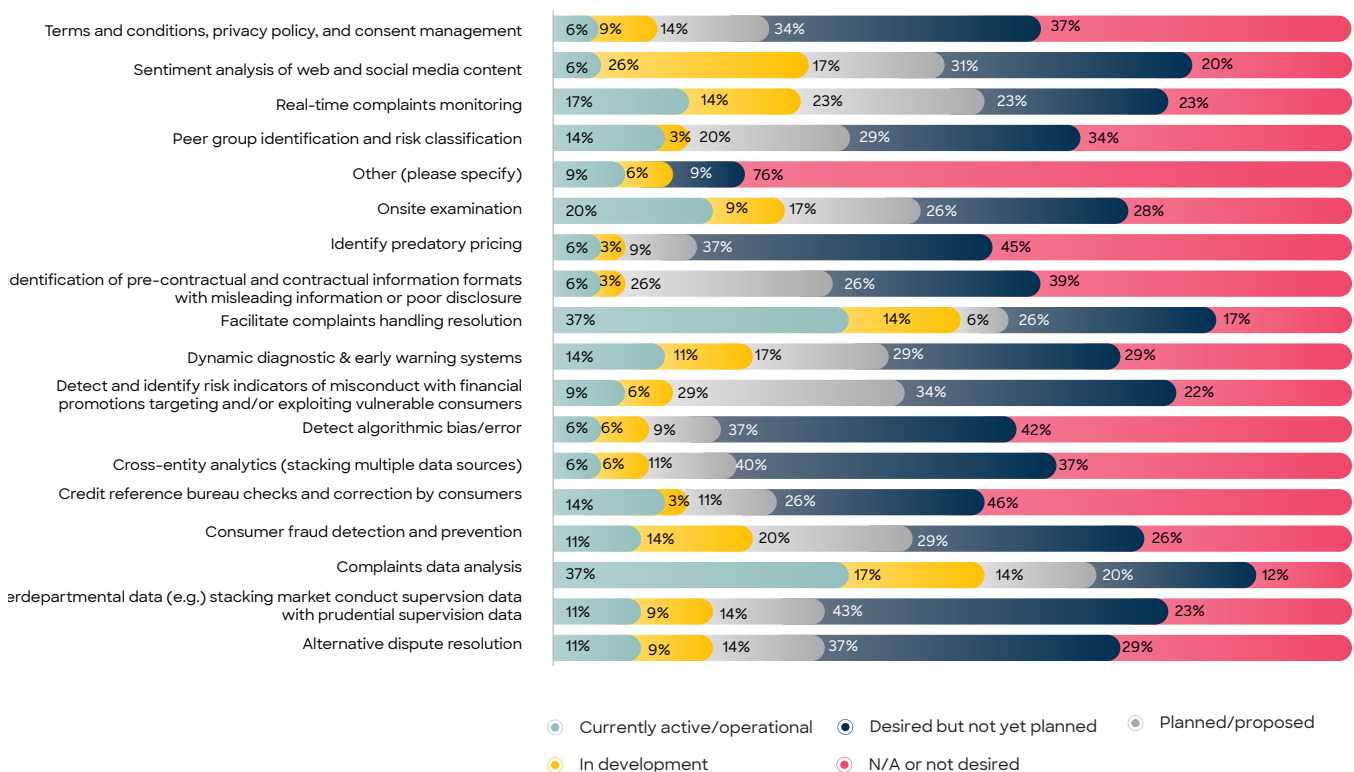
Focus on licensing and compliance assistance has increased for AEs and EMDEs alike. Suptech for insurance supervision has been driven primarily by authorities in AEs, while suptech for financial inclusion is an objective primarily for those in EMDEs.

The percentage of respondents who cite compliance assistance as an objective has increased by 27%, licensing has increased by 17% and financial inclusion monitoring by 12%. Together, these could be taken to indicate a focus on emerging disruptive technologies, including formal classification, reporting, and study of their impact on the underserved portions of the market. Financial inclusion monitoring remains a substantial priority for EMDEs, with 34%, surpassing the focus in AEs, which stands at 18%. (See section 3.2).

Financial authorities in EMDEs lead the deployment of suptech applications for consumer protection and market conduct supervision, which (across AEs and EMDEs) focus primarily on complaints handling and analysis, along with sentiment analysis of web and social media content.

In the context of consumer protection and market conduct, there is a notable difference in focus between supervisory agencies in EMDEs and those in AEs. A higher percentage of EMDEs' supervisory agencies (68%) have prioritised these areas compared to their AE counterparts (47%). Globally, respondents this year have highlighted the launch of solutions aimed at enhancing complaints handling and analysis (37%) as the top one operational suptech solution across all supervisory domains.

FIGURE 12.
PRIORITIZATION OF SUPTECH USE CASES UNDER CONSUMER PROTECTION AND MARKET CONDUCT SUPERVISION (N=35)



Moreover, a significant number of agencies are in the process of developing projects for sentiment analysis of web and social media content (26%), demonstrating a proactive approach towards leveraging technology for better consumer insight and protection. (See section 4.1).

By focusing on consumer complaints and deploying scrapers, financial authorities are “[democratising](#)” financial consumer protection, ensuring that users have proper access to redress and support. These agencies are actively working towards guaranteeing fair treatment in the financial ecosystem and enhancing their grasp of the customer experience to pinpoint barriers to financial access and utilisation. This proactive stance also facilitates the early identification and mitigation of potential risks.

The valuable insights gleaned from analysing consumer complaints, such as those produced during the Lab’s [Hackathon 2023](#), empower supervisors to make well-informed decisions. This intelligence allows for the strategic allocation of resources and the adjustment of supervisory practices to safeguard consumers, whose behaviors are rapidly evolving alongside the progressive digitalisation and datafication of the economy.

The case studies section of this report highlights significant developments under each of these areas. For example, the Bangko Sentral ng Pilipinas (BSP), the Securities and Exchange Commission (SEC) Philippines, the Superintendencia de Banca, Seguros y AFP (SBS) of Peru, the Indonesian Otoritas Jasa Keuangan (Financial Services Authority) (OJK), and the Bank of Ghana (BOG) have partnered with vendors Proto, Winnow Technologies, and FNA to develop suptech solutions to address challenges in these areas under the Lab’s [Launchpad](#) accelerator.

The AI-powered complaints management system and chatbot is set to become one of the first globally scaled 3G/4G suptech applications.

The complaints management system and chatbot solution was first conceived in 2017 by the RegTech for Regulators Accelerator (R₂A, the precursor of the Cambridge SupTech Lab) and the Philippines BSP. The multichannel (webchat, Facebook, and SMS – the latter needed to enable access to the system to consumers who use a flip phone), multilingual solution was prototyped the following year with the vendor Proto. The success of that project laid the foundation for subsequent deployments of similar solutions across the world.

Following the initiative in the Philippines, the concept was introduced at a R2A workshop with the Superintendencia Financiera de Colombia (SFC), where the challenges of enhancing market conduct supervision and devising a unified application for use by multiple public agencies were explored. This included the central bank, financial supervisory authority, and consumer ombudsman. The workshop led to the conceptualisation of a new proof of concept (POC) that proposed a two-pronged solution: A white-label chatbot that could be integrated into financial institutions’ apps and websites, and a complaints management system that would be interoperable across several government bodies. This system aimed to centralise the collection of consumer grievances lodged with financial entities, providing a uniform experience for consumers across various products and financial service providers. For regulators, it promised a more robust oversight mechanism of the complaints filed and the customer service quality metrics, such as resolution times.

R₂A subsequently seeded a partnership involving Proto, the Bank of Ghana, the

National Bank of Rwanda, the Bank of Zambia, and Zambia's Competition and Consumer Protection Commission, backed by the African Development Bank's Africa Digital Financial Inclusion (ADFI) facility. This initiative contributed significantly to the advancement of the consumer protection stack, additional accessibility functions through additional local languages and channels (e.g. IVR), and tested the white label model at scale. Building on this, the Philippines' BSP solution, extended in Colombia and refined across Africa, is now in its second chapter. It has seen widespread adoption across ten government agencies beyond the central bank and has been replicated in regions across Asia, Africa, and Latin America. This marks it as the first modern suptech application to be deployed on a global scale.

The AI-powered complaints management system and chatbot is

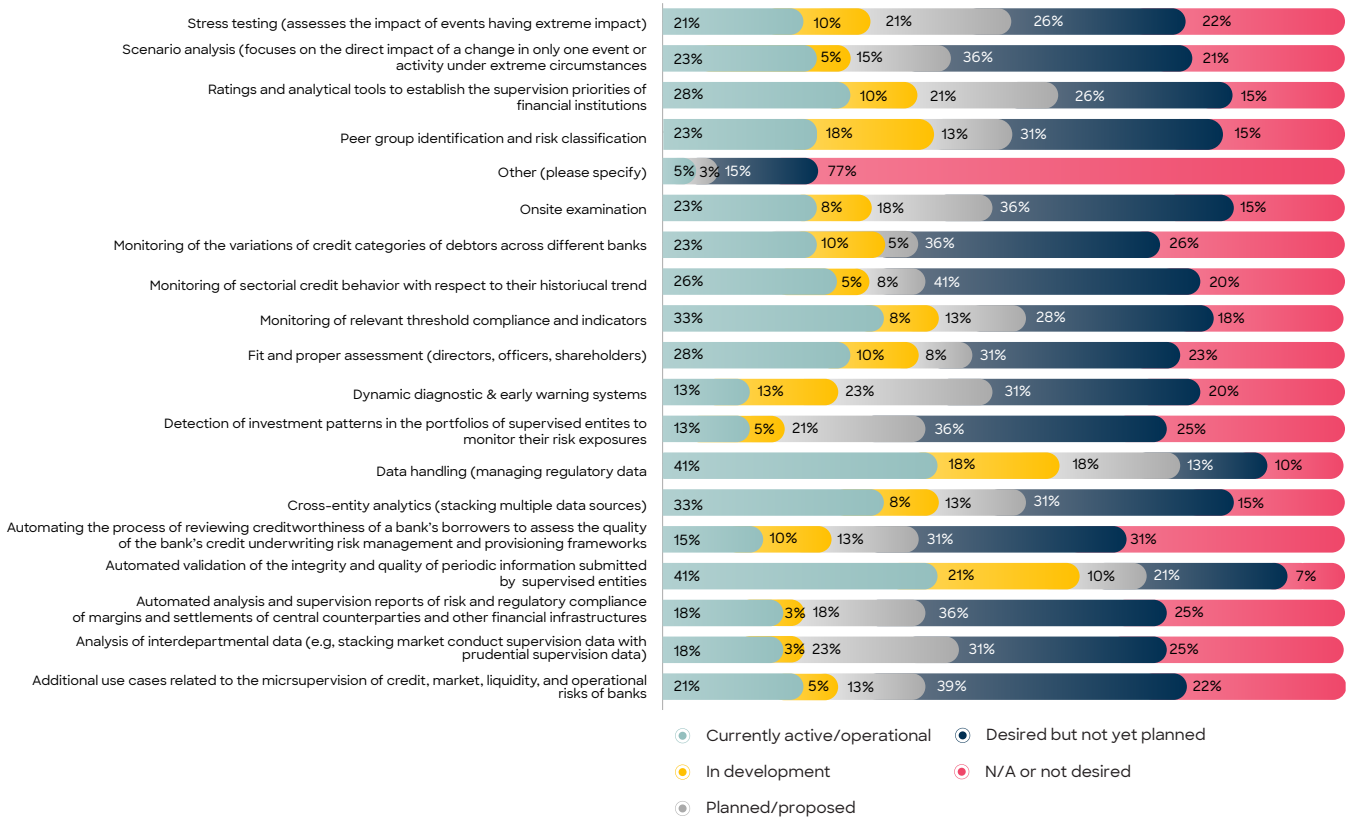
set to become the first globally scaled 3G/4G suptech application.

The SupTech Launchpad 2023 has facilitated further advancements to this solution. Generative AI has been incorporated into the chatbot functionalities by Proto, and Winnow Technologies has integrated a component enabling sentiment analysis and the extraction of more detailed insights from complaints datasets, social media, and app store reviews, enhancing the system's overall capability and value. (See section 4.1).

Suptech deployments in prudential supervision focus primarily on the collection and management of regulatory data.

In the realm of prudential supervision, 41% of the respondents have given priority

FIGURE 13. PRIORITIZATION OF SUPTECH USE CASES UNDER PRUDENTIAL SUPERVISION (N=43)



to use cases related to the collection, validation, and management of regulatory data.

Three notable illustrations of such suptech applications are the deployments in the European Union, in Rwanda, and in the Philippines.

The [API-based Prudential Reporting System](#) implemented by the Philippines BSP is a 2G/3G data collection system – described in detail in the State of SupTech Report 2022 – that enables financial institutions to digitally submit high-quality, granular data automatically to the financial authority, increasing the frequency of submissions. It has further empowered BSP staff to expedite data validation and enhance analysis by generating customised reports in various formats for supervisory and policy development purposes.

Another example is the Electronic Data Warehouse (EDW) initiative by the National Bank of Rwanda (BNR), serving as a

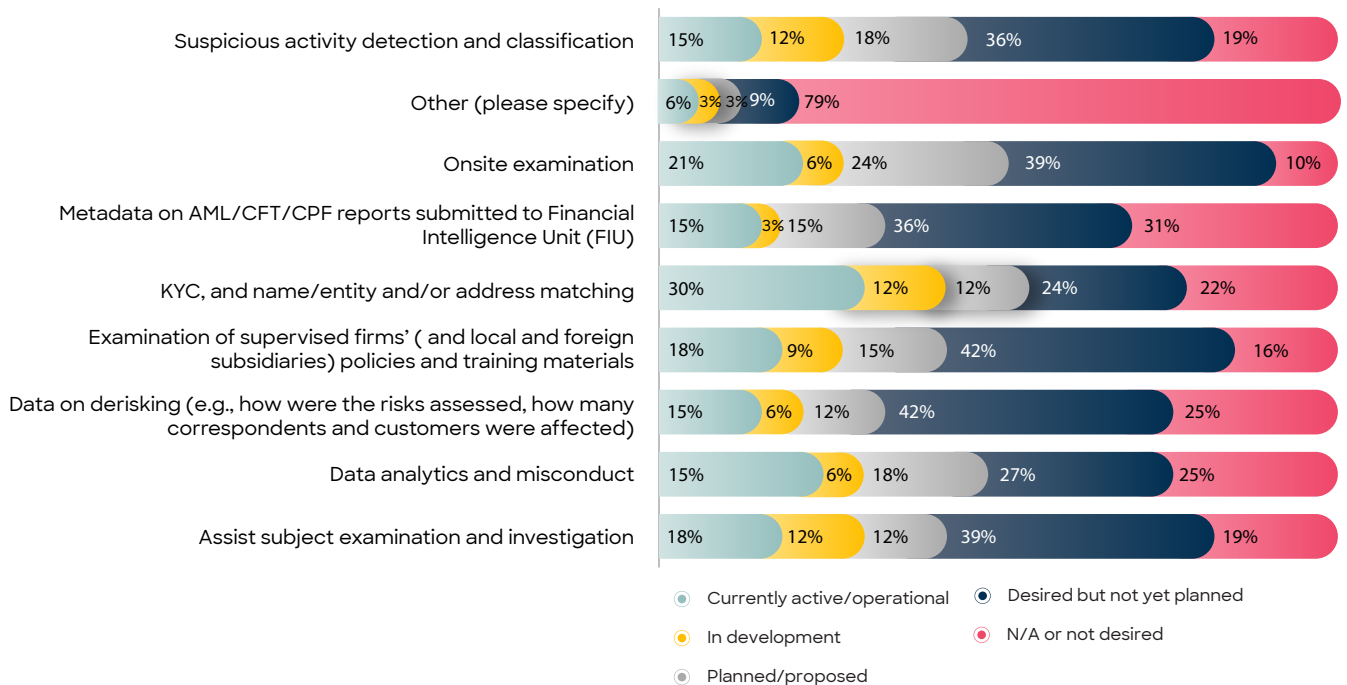
supervision information system (SIS) built on an end-to-end regulatory reporting data platform. This 3G/4G data storage platform (also described in the State of SupTech Report 2022) encompasses both prudential and market conduct applications.

Finally, as highlighted in the case studies section of this report, the European Central Bank’s (ECB) Athena platform is an AI-driven textual analysis tool for use within their single supervisory mechanism (SSM). This 4G processing tool and data product underpins specific applications in prudential supervision.

Deployed AML/CFT/CPF solutions were most prevalent for KYC and misconduct analysis use cases.

In the realm of AML/CFT/CPF, the use cases on Know Your Customer (KYC) processes and name/entity and address matching (30%), alongside data analytics on misconduct (24%) take priority.

FIGURE 14.
PRIORITIZATION OF SUPTECH CASES UNDER AML/CFT/CPF SUPERVISION (N=33)



Suptech is transforming AML supervision by enabling significant strides in combating global financial crime. Some applications to highlight have been developed by De Nederlandsche Bank (DNB), the Financial Transactions and Reports Analysis Centre of Canada (FINTRAC) and MAS. DNB utilises advanced data analytics to assess the risk and control frameworks of supervised entities comprehensively. DNB's approach includes a network analysis tool to trace fund transfers to high-risk jurisdictions and a machine learning-based tool for scrutinising banks' internal control frameworks, which enable the building of detailed risk profiles for financial institutions.

Similarly, FINTRAC has developed a heuristic model that evaluates the effectiveness of financial institutions' control frameworks. This model integrates natural language processing and a risk-scoring model with an adaptive learning approach. This multifaceted platform empowers financial authorities to detect and address money laundering and other related financial misconduct more efficiently.

Another illustration is the case of the MAS, which uses analytical tools to scrutinise unusual transactions, reduce manual data reviews, and employ predictive

models for misconduct risk. Also, MAS is developing COSMIC, a digital platform for collaborative sharing of money laundering/terrorism financing (ML/TF) information, in partnership with six major banks in Singapore. Focusing on risks like misuse of legal persons, illicit trade finance, and proliferation financing, COSMIC will allow financial institutions to share information on suspicious customers, enhancing their capacity to detect and deter financial crime.

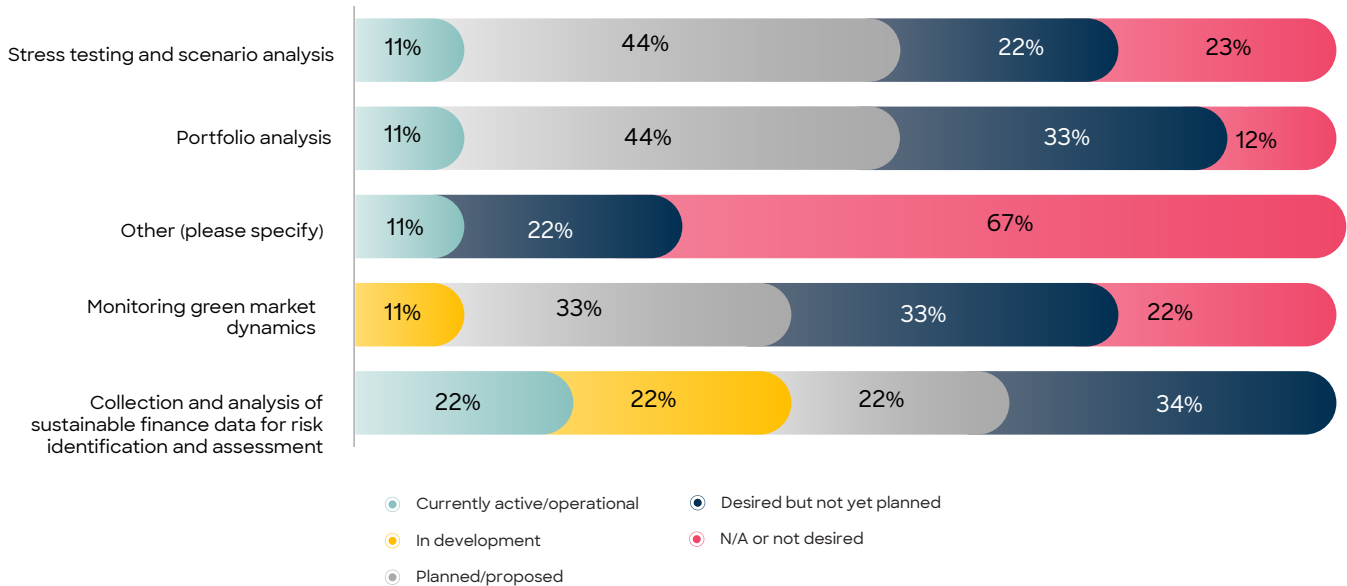
Additionally, the BIS Innovation Hub's Nordic Centre is advancing collaborative efforts with [Project Aurora](#). This project combines payment data, privacy-enhancing technologies, AI, and cross-institutional and cross-border cooperation, responding to global financial crime networks' complex and interconnected nature. Project Aurora aligns with the Financial Action Task Force's (FATF) recommendations on data-sharing and collaborative analytics, marking a crucial step in advancing global AML/CFT efforts.

These developments underscore the transformative impact of suptech in AML/CFT/CPF supervision, showcasing a strategic shift towards more interconnected and data-driven financial supervisory practices.



FIGURE 15.

CLIMATE/ESG RISKS SUPERVISION - PRIORITISATION OF SUPTECH USE CASES (N=9)



Collection and analysis of sustainable finance data (ESGs) was the most common use case addressed by suptech deployments in climate risk supervision.

The modest response rate to the ESG segment of our survey underscores the need for growth in this domain. ESG issues, especially within green finance, are gaining traction as the urgency to address environmental concerns intensifies. Global cooperative efforts, such as those seen in the COP conferences, the most recent of which was hosted by the United Arab Emirates, provide critical platforms for key players to seek unified action. Notably, the BIS and United Arab Emirates central bank implemented a global [techsprint](#) championing sustainable finance and climate change mitigation solutions. The showcased applications leveraged AI and blockchain for more effective reporting, verification, and disclosure to scale sustainable finance and fight climate change.

The State of SupTech 2023 survey illustrates the adoption of tools for sustainable finance data collection, aimed at identifying risks and analyzing investment portfolios for alignment with sustainable development objectives. While the former requires a cross-disciplinary approach due to the complexity of the risks involved, the latter is an evolving endeavour.

Assessing the environmental integrity of purportedly sustainable financial investments is challenging, given the profusion of diverse frameworks and the presence of unreliable rating agencies, which muddles the landscape for investors and regulators alike. To address this, global standard setting bodies (i.e., the International Auditing and Assurance Standards Board, IAASB) are striving to devise tools such as standardised audit procedures, a clear taxonomy of activities, and consistent financial accounting standards, all while ensuring these instruments are robust and user-friendly.

To align investors towards ESG-oriented

investments, financial supervisors are exploring technology solutions to detect greenwashing more effectively and efficiently. Project Carbon Counter, developed by ACPR/Banque de France, evaluates insurers' environmental performance by considering industry-specific challenges, risk profiles, and the net contributions of the firms/sovereigns in which they are investing. This tool is a central resource for investors, enabling them to conduct forward-looking analyses of CO2-related risks at both the issuer and portfolio levels.

Another noteworthy initiative in the ESG realm is [Project Gaia](#), by the BIS, the ECB, Banco de España and the Deutsche Bundesbank. Gaia aims to investigate the viability of employing natural language processing (NLP) and large language models (LLM) to extract and organise climate-related data from corporate reports and news sources. These cutting-edge tools will enhance the usability of unstructured data, streamlining climate

risk assessments.

Despite significant progress in the collection of sex-disaggregated data, many authorities have yet to adopt this practice.

Although there's been a marked advancement in the collection of sex-disaggregated data in the last years, still a mere 45% of financial authorities are currently engaging in this practice.

The growing acknowledgement of the necessity and value of such data underscores the need to embed this practice into both formal gender and data strategies. The collection of sex-disaggregated data not only serves as a barometer for the effectiveness of financial inclusion initiatives, but also provides nuanced insights into the specific challenges faced by women in the financial realm.

FIGURE 16.
DOES YOUR AGENCY COLLECT SEX-DISAGGREGATED DATA? (N=53)

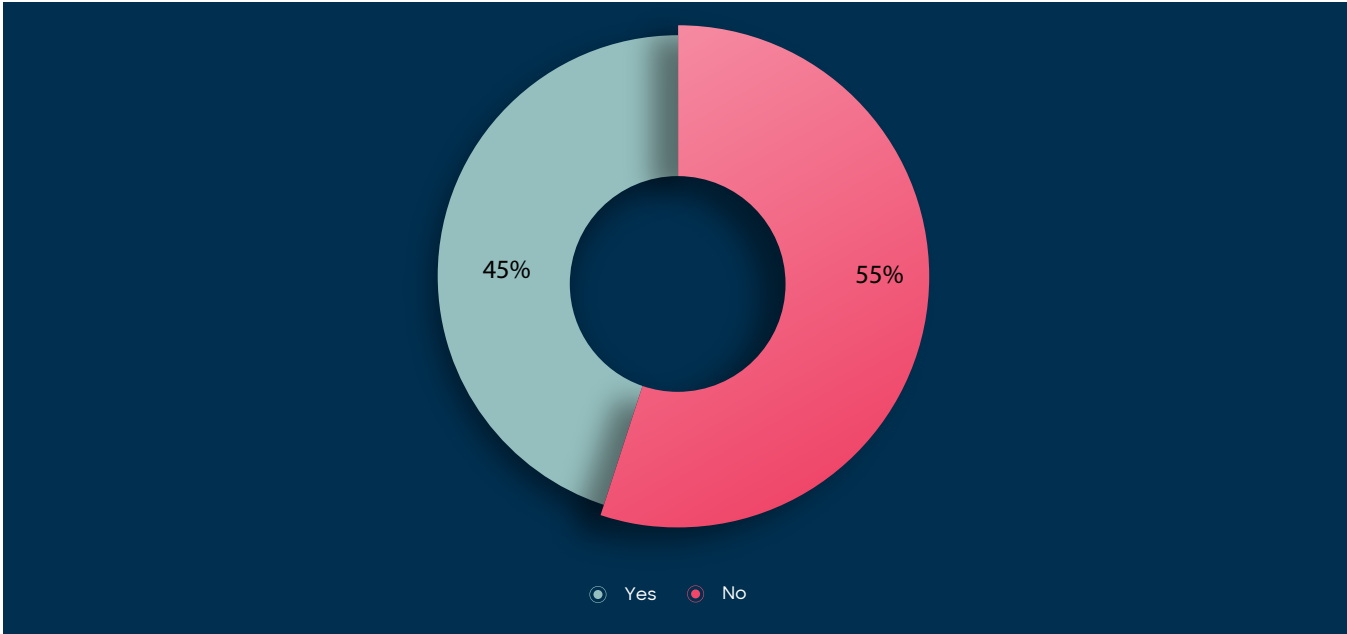


FIGURE 17.
WHAT TYPES OF SEX-DISAGGREGATED DATA DOES THE AGENCY COLLECT? (N=24)

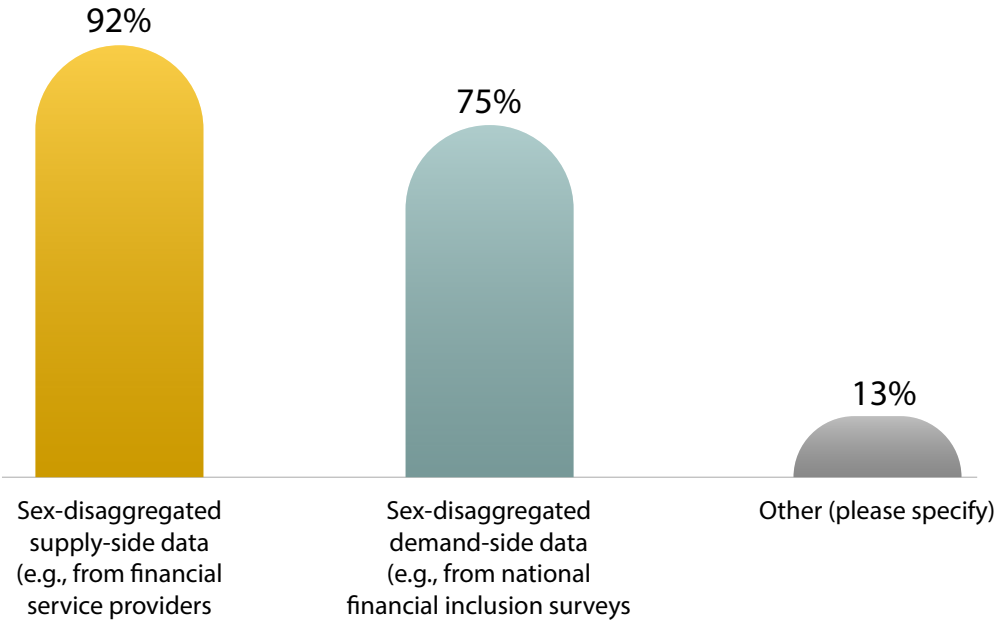
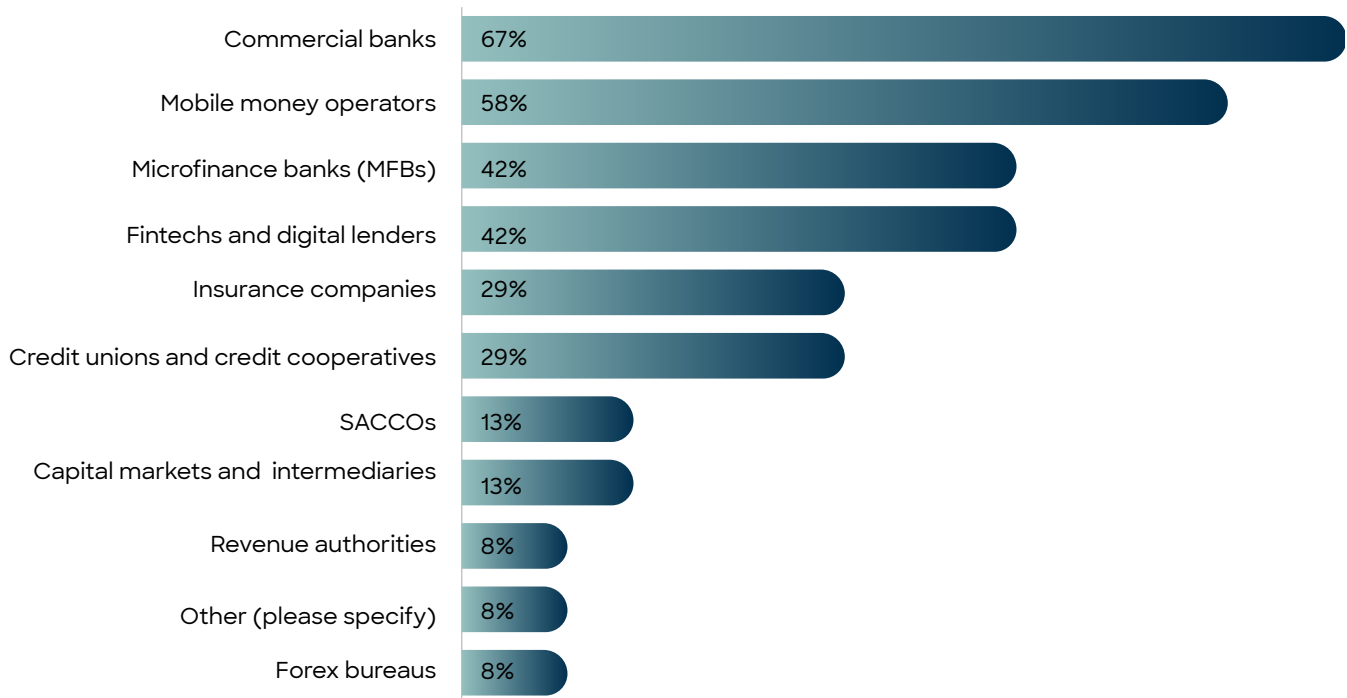


FIGURE 18.
WHO ARE THE PRODUCERS OF SEX-DISAGGREGATED DATA COLLECTED BY YOUR AGENCY? (N=24)



Financial authorities are collecting sex-disaggregated data from both supply- and demand-side sources.

The subset of financial authorities actively collecting sex-disaggregated data are sourcing them both from supply-side data from supervised entities (92%) and demand-side datasets from national surveys and the like (75%). The synthesis of supply-side and demand-side data not only enhances the comprehensiveness of the dataset but also provides a multifaceted perspective on gender dynamics within the financial landscape.

Sex-disaggregated supervisory data is collected primarily from banks, mobile money operators, and fintechs, while other financial entity types lag.

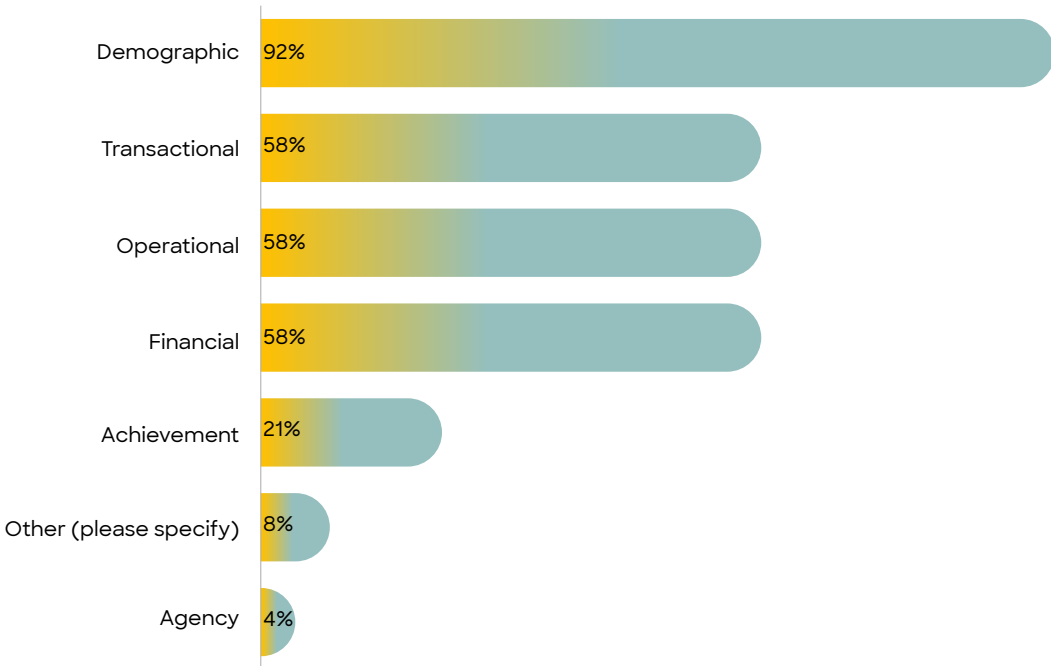
Financial authorities are in a position where they can suggest, mandate, or even enforce via suptech solutions

data schemas that must be reported from both supply and demand sides, which may be taken as an opportunity to actively advocate for sex- and/or gender-disaggregated data and enrich the resulting supervisory analytics and outcomes.

In breaking down the supply-side sources further, it perhaps comes as no surprise that the primary contributors to sex-disaggregated data within the financial sector are commercial banks (66.7%) and mobile money operators (58.3%). However, it is notable to see the commitment to sex-disaggregated data spanning a diversity of organisation types, though there is importantly significant room for improvement across the board.

Financial authorities are in a unique position to move the needle on sex- and gender-disaggregated data.

FIGURE 19.
WHAT CATEGORIES OF SEX-DISAGGREGATED DATA DOES YOUR AGENCY COLLECT? (N=24)



Sex-disaggregated data is primarily sourced through datasets collected for demographic purposes, but is also embedded in transactional, operational, and financial data.

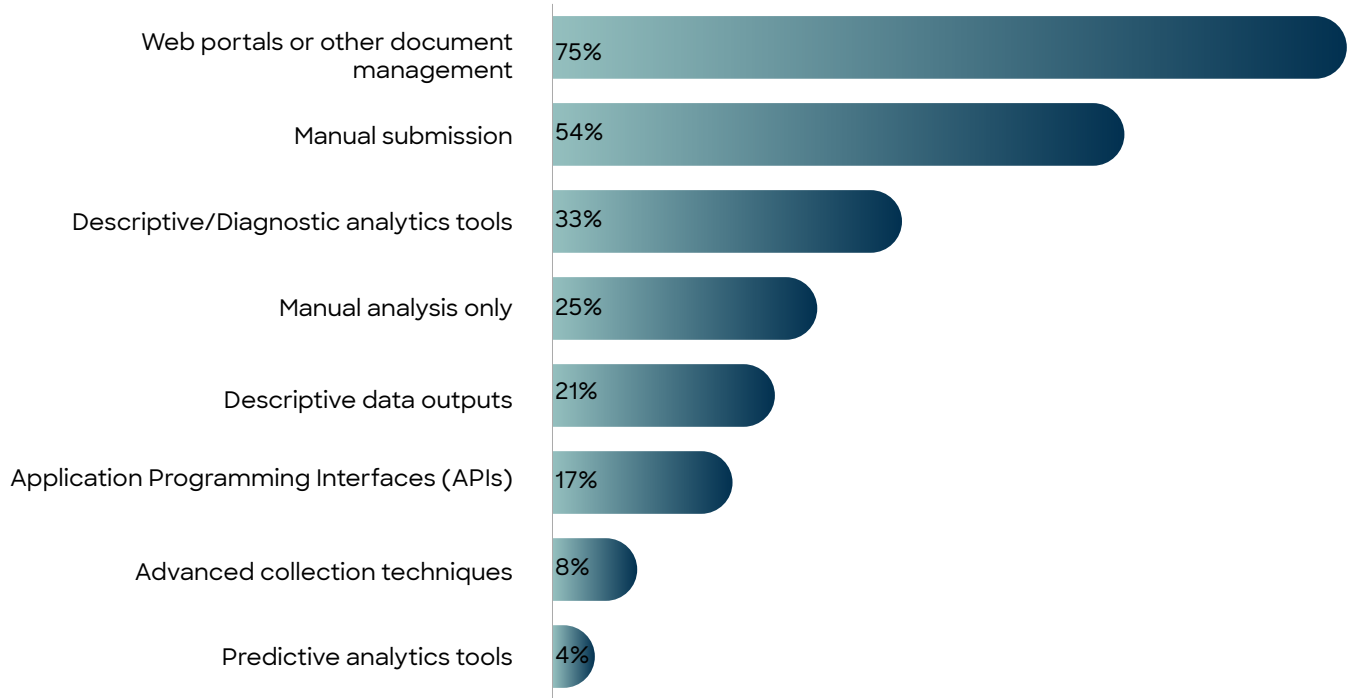
The preeminent category of gender-disaggregated data collected by financial authorities is demographic data (91.7%), marking a foundational understanding of the gender-specific composition within financial systems. This dataset encompasses a range of factors such as age, location, and socio-economic background, offering valuable insights into the diverse demographics of financial services users. Financial authorities also prioritise the collection of transactional data (58.3%), providing a nuanced perspective on the gender-specific patterns of financial transactions, financial data delving into the specifics of income, savings, and expenditure patterns based on gender and operational data which

sheds light on the operational aspects of financial institutions and how they interact with diverse gender groups.

While demographic data is valuable for understanding the overall gender composition in financial systems, there are notable disadvantages. Overreliance on demographic data may lead to oversimplifications, stereotyping, and a lack of nuanced understanding of individual differences within gender groups.

Demographic data alone may not capture the complexities of access, usage, and barriers faced by individuals from various genders. It may lack the granularity required to identify specific challenges, such as disparities in financial literacy, employment opportunities, or cultural factors that influence financial decision-making. A more comprehensive approach that incorporates more transactional,

FIGURE 20.
HOW DOES YOUR AGENCY COLLECT, ANALYSE, AND SHARE SEX-DISAGGREGATED DATA? (N=24)



financial data (e.g., fee revenue, nonperforming loans by credit type, total e-money issued), and operational data (e.g., number of loans, depositors, agents, consumer complaints, fraud reports), agency data (e.g., control over finances, mobility, control over time, privacy, self-esteem (self-efficacy) and data on achievement/impact (e.g., changes in assets, changes in financial health, and changes in women's role, influence within their communities) can provide a more holistic and actionable insight into the challenges and opportunities for achieving gender-inclusive financial systems.

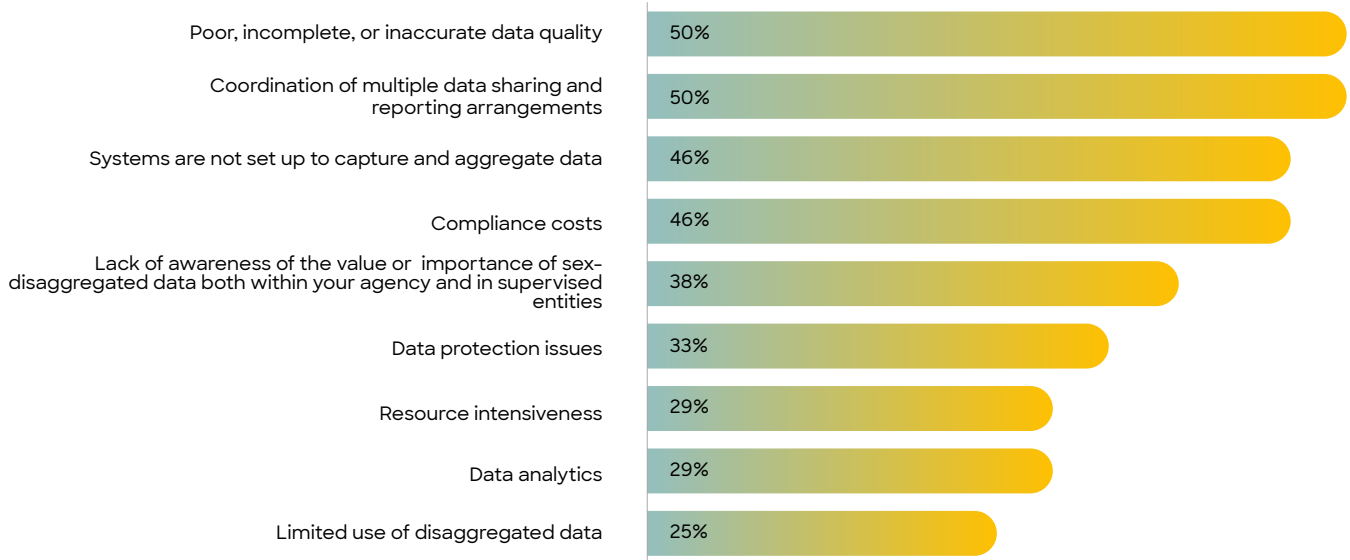
Sex-disaggregated supervisory data is typically collected through 1G and 2G solutions, which can limit efficiency of collection, automation of validation, and thus downstream utility in the form of analysis.

Similar to the trends previously noted in the broader set of supotech solutions across

the supervisory data stack, the collection and analysis of gender-disaggregated data by financial authorities predominantly reside within the first and second phases of supotech generation technologies. The continued reliance on the first and second phases of supotech generation technologies for the collection and analysis of gender-disaggregated data introduces certain drawbacks.

These early phases, characterised by relatively basic analytical capabilities, pose specific challenges in achieving in-depth insights into the complex nuances of gender dynamics within financial systems. The focus on structured data may oversimplify the understanding of intricate social and cultural factors influencing financial behaviours, potentially leading to superficial interpretations. Furthermore, the limitations of these phases may hinder the ability to adapt to emerging challenges and evolving patterns in gender-specific financial behaviours, limiting the effectiveness of policies promoting financial inclusion.

FIGURE 21.
WHAT CHALLENGES DOES THE AGENCY FACE IN THE COLLECTION AND USE OF SEX-DISAGGREGATED DATA? (N=24)



The challenges associated with collection of sex-disaggregated supervisory data are those associated with earlier-generation (1G/2G) supotech: data quality, processing, and associated costs.

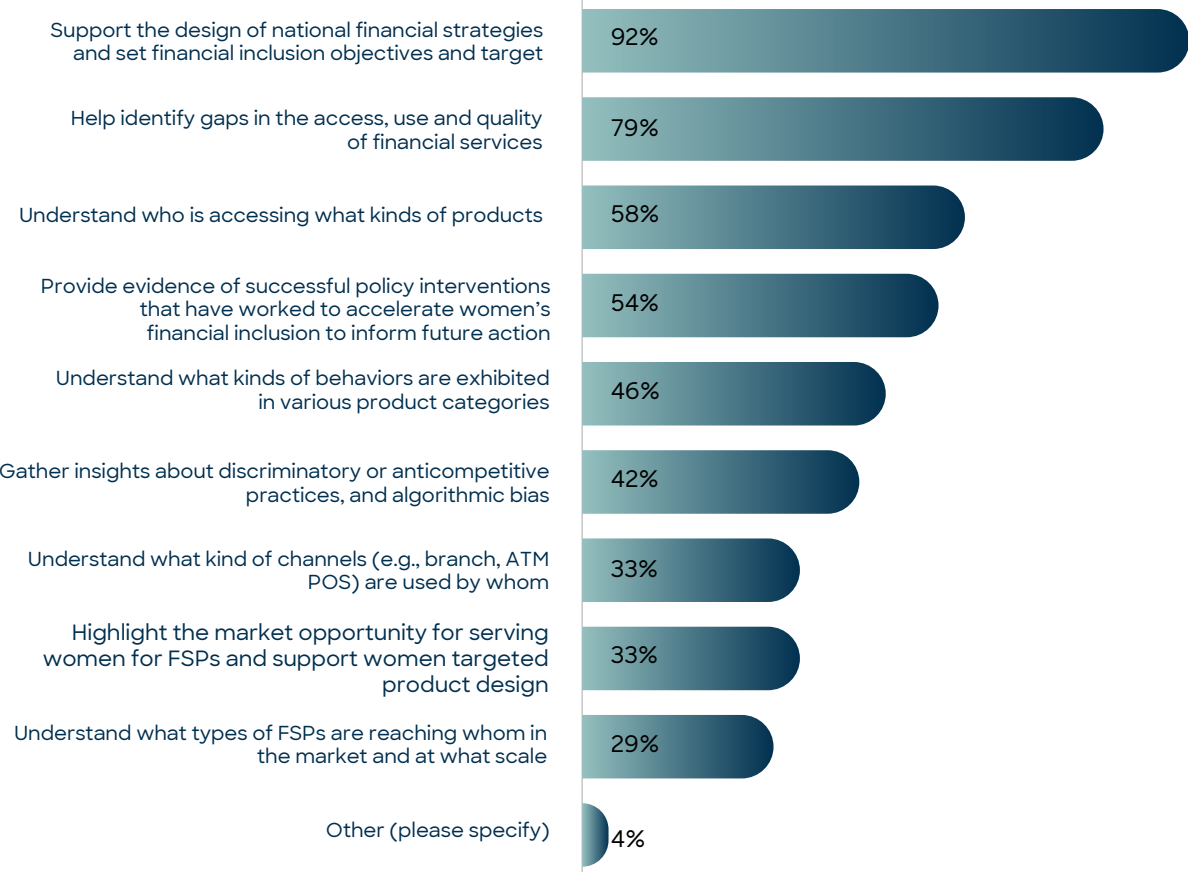
It is not surprising therefore that the collection and analysis of gender-disaggregated data by financial authorities are confronted with various challenges. One significant hurdle is the issue of poor, incomplete, or inaccurate data quality (50%), which undermines the reliability of the insights drawn from the collected information.

The coordination of multiple data sharing and reporting arrangements (50%) poses another obstacle, as disparate systems

and processes can impede the seamless integration of gender-specific data. Additionally, 45.8% report the absence of systems configured to capture and aggregate such data which can hinder the efficiency of the collection process.

To overcome these challenges, financial authorities could invest in validation checks and cleansing processes (e.g., via later-generation supotech) to rectify inaccuracies. Coordinated mechanisms for data sharing and reporting need establishment, promoting standardised protocols for seamless integration across different systems. The upgrading of data capture systems involves investing in modernised, scalable platforms designed to efficiently store and aggregate gender-disaggregated data. Additionally,

FIGURE 22.
HOW DOES THE AGENCY USE SEX-DISAGGREGATED DATA? (N=24)



AI-powered analytics could be deployed to extract more insights into gender-specific financial behaviours.

Sex-disaggregated supervisory data is critical for assessing effectiveness of policy for inclusive financial systems, through identifying and closing gaps in access, use, and quality of financial products and services.

Financial authorities utilise sex-disaggregated data in various ways, with the majority reporting that they employ it to support the design of national financial inclusion strategies and establish specific objectives and targets for financial inclusion (91.7%). Additionally, financial authorities leverage sex-disaggregated data to identify gaps in the access, usage, and quality of financial services (79.2%).

Importantly, however, it goes well beyond inclusion in the form of access and usage, and is leveraged in myriad other, perhaps less obvious, mechanisms. Newly prominent topics like identification and mitigation of algorithmic bias, financial health, and consumer outcomes depend fundamentally on access to sex- and/or gender-disaggregated data. As financial authorities continue to introduce suptech tools that interact directly with financial consumers, such as complaints chatbots, it is crucial that they have data to inform the design and go-to-market strategies for these products. As such, the implications of having or not having this sex- and/or gender-disaggregated data at hand are not to be understated.

3.3. The tech in suptech

3.3.1. The DataStack and the SupTech Taxonomy

In section 3.2, the Report provided a detailed examination of the state of suptech by supervisory area and use case. Complementing this, an analysis through the prism of the technical supervisory data stack is presented in this section. This analysis is guided by the DataStack Framework, which delineates how dashboards and data products are directly tied to their underlying raw data sources, taking into account the necessary processes for data collection, validation, processing, storage, and analysis.

The importance of this structured approach to data is further articulated in the R₂A [report](#) that initially presented the DataStack framework. The nuanced potential value of this methodological data handling is expounded within the report:

“The DataStack offers a modular, interoperable approach that allows various personas to surface insights efficiently and securely in digestible formats. It is technology-agnostic in that it seeks to assemble the most suitable, cost-effective, and innovative parts for every layer and application of the stack.

To help financial and monetary authorities harness data profusion, DataStack favours solutions that are capable of handling large volumes of data efficiently and at a high velocity and bandwidth.

It facilitates data interoperability to fix coordination failures in the data economy by creating a platform that can integrate different types of data from various sources, and by providing a means to share and disseminate that data for wider use. Better data management and the application of cutting-edge suptech solutions, in turn, will generate insights that can inform and guide personas of all

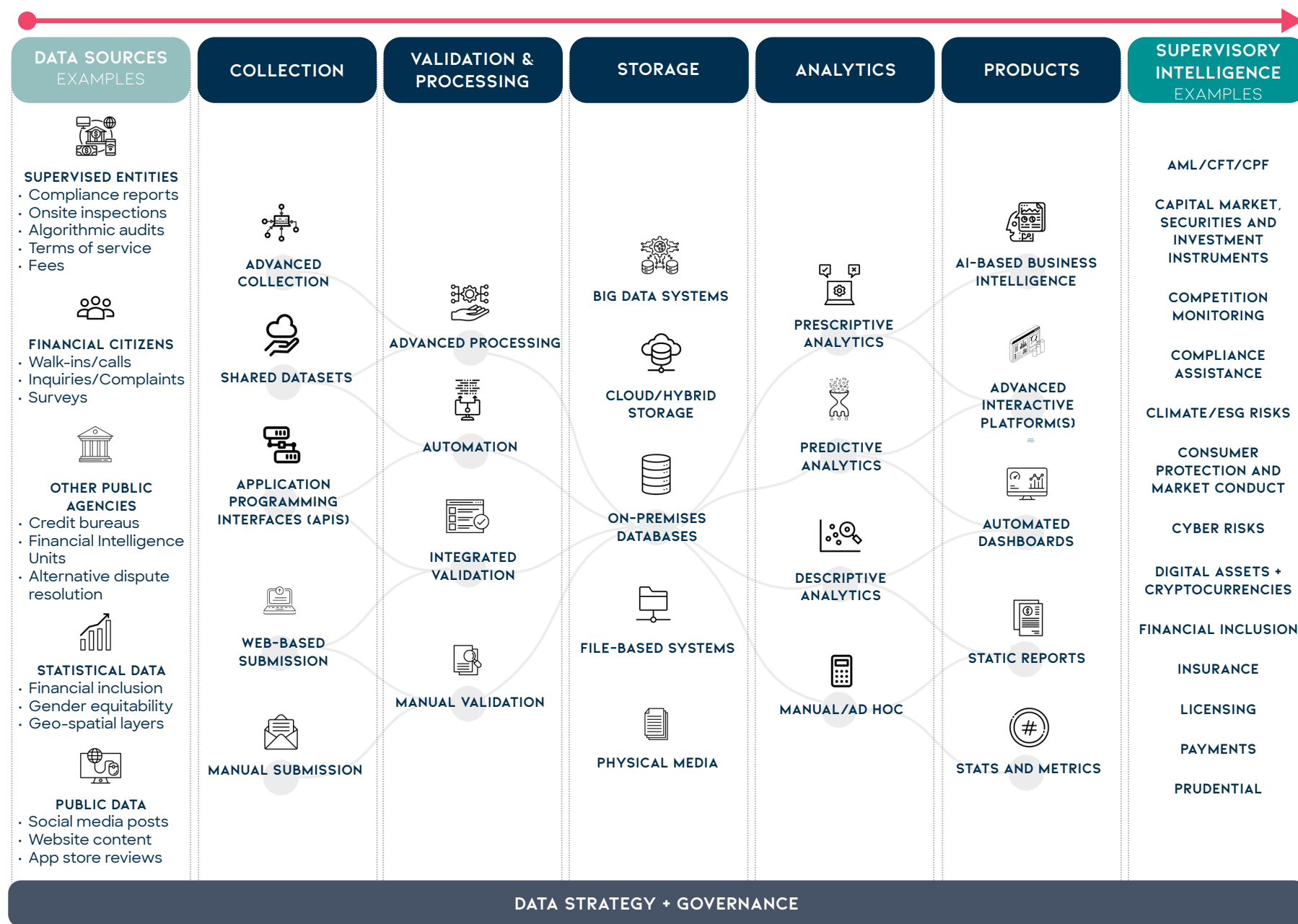
types, be they policymakers at financial and monetary authorities or private sector analysts. In fact, by reducing the data gaps, the DataStack creates value across the whole financial ecosystem with the public sector as the catalyst.”

Additionally, the technical supervisory data stack’s relevance is mirrored in the second part of the SupTech Taxonomy found in Appendix 2, illustrating the taxonomy’s comprehensive nature and its utility for supervisory technology.

The DataStack framework empowers financial authorities and their partners to modularise the diagnosis, design, and development of suptech solutions, facilitating the pursuit of simultaneous progress pathways.

Aligning documentation, systems design, and technical architecture with the DataStack framework enables a structured and modularised approach to diagnosing and strategising suptech initiatives. This approach helps financial authorities to recognise that different layers of the data stack may demand varying resources, thereby promoting a development process that is both customised and agile. For instance, while an agency might have the in-house IT capacity to advance data collection and storage solutions, they might concurrently seek external procurement for sophisticated analytics and interactive dashboards. The DataStack methodology supports these varied, simultaneous advancements across different layers.

FIGURE 23.
DATASTACK FRAMEWORK



[See Appendix 3 for definitions.](#)

Suptech solutions are designed to enhance at least one layer of the DataStack, and often they intersect multiple or all layers. With this perspective, subsequent sections of the report will discuss the current state of suptech within the distinct layers outlined in the SupTech Taxonomy.

3.3.2. Data collection

Data collection mechanisms serve as a central point for gathering and consolidating information within the supervisor’s domain. Many supervisory activities rely on aggregated data reported through pre-defined templates, simplifying the collection process for supervisors but placing a burden on data providers whose systems may not automatically format data as required.

Low data quality often results from manual processes and the laborious task of filling out report templates, leading to redundancies, mistakes, and costly reconciliation and validation processes. In low-tech settings or for specific use cases, data can be conveyed verbally or

through unsecure channels like email with attachments. An improvement from this is using File Transfer Protocol (FTP), which offers better security and can transmit larger files.

The optimisation of data collection via suptech involves leveraging advanced channels such as web portal platforms, application programming interfaces (APIs) and web scraping tools, offering substantial relief from manual processing. Additionally, implementing automated validations within these collection mechanisms can prevent submissions with missing essential information or deviations from required formats or thresholds. These technologies are crucial for clearly defining and enforcing submission obligations.

An advantageous aspect of implementing a suptech platform that accommodates diverse requirements is its support for multiple applications across various supervisory use cases. The greater the consolidation and integration of this platform, the lower the operational maintenance and support costs become.

FIGURE 24.
WHICH ENTITIES ARE DATA SOURCED FROM? (N=54)

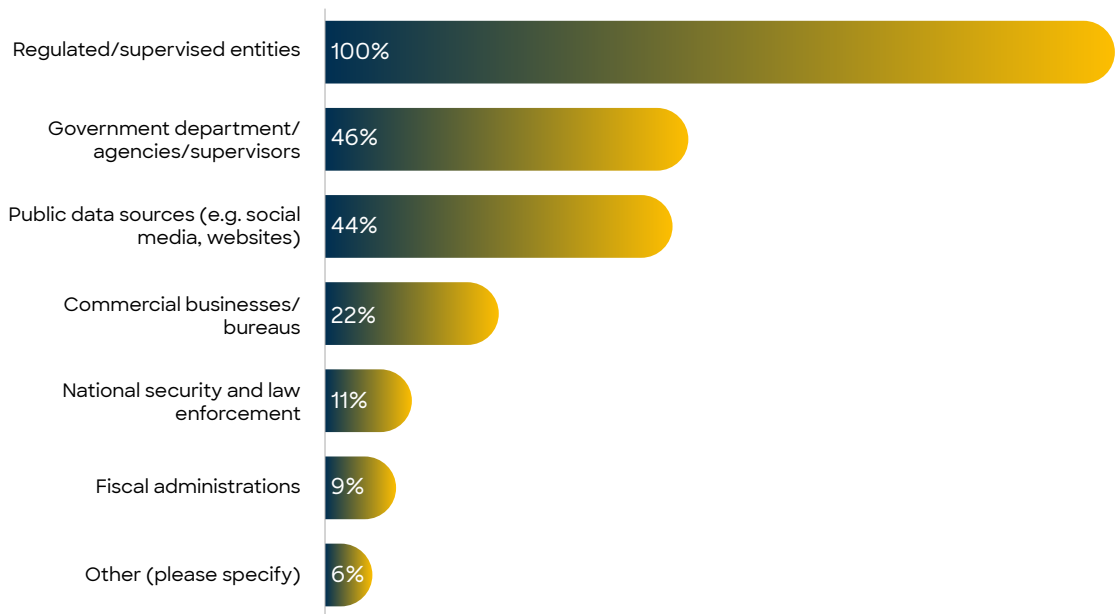
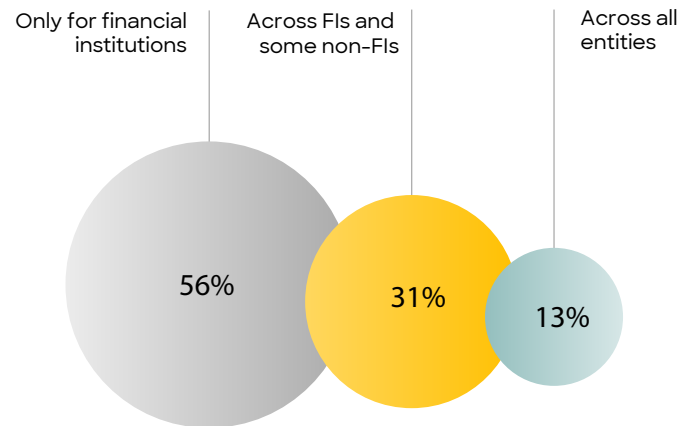


FIGURE 25.

ARE THERE STANDARD DATA DEFINITIONS AND DATA COLLECTION TEMPLATES IN PLACE?
(N=52)



Traditional data collection from supervised entities is being complemented by interagency data sharing and collection of less-structured public online data.

Expectedly, all respondents to the survey indicated active data collection from entities under supervision. Additionally, a significant portion (46.3%) gather data from peer government departments, and from public data sources such as websites, social media, and app stores (44%).

A noteworthy data point is that over 58% of the public data collectors are from advanced economies (AEs), suggesting a link between the ability to collect and analyse web and social media data at scale and the availability of advanced 4G supotech capabilities. These include sophisticated data collection methods, advanced text and image processing, big data analysis tools, and AI-enhanced business intelligence tools.

For instance, a case study discussed in section 4.1.1 of this Report demonstrates a working prototype with a limited scope covering a few entities, yet capable of collecting and conducting advanced analysis of over 70,000 web-based posts.

Few agencies are applying standard data schemas across their collection mechanisms.

Only a small fraction of authorities, about 14%, report employing standardised data definitions across all entities they supervise. Consequently, the majority, or 86%, are handling some degree of non-standardised data, which necessitates additional manual efforts to reformat this data to meet supervisory needs.

This situation presents a significant opportunity for enhancing supervisory efficiency through cross-jurisdictional collaboration. By developing global standards and employing collaborative approaches such as tech sprints, hackathons, and working groups, authorities can work towards harmonisation and reduce the manual workload associated with data preparation.

Despite the challenges, there is a foundation of progress to build upon. More than half of the financial authorities, specifically 55.8%, have already adopted standard data definitions and collection templates for financial institutions. This adoption indicates a movement towards greater consistency in data collection practices within the financial sector.

To further elaborate, in the European Union (EU), [efforts are underway](#) to modernise supervisory reporting, taking a gradual approach that builds on existing tools. The European Commission is collaborating with relevant stakeholders, including EU and national authorities and industry, to progress in the implementation of the supervisory data strategy.

This endeavour aims to increase the consistency and standardisation of data, enhance data sharing among authorities, and utilise modern technologies to streamline data collection and reporting processes.

Suptech solutions focused on data collection must account for a diversity of technical capabilities of supervised entities, ranging from manual submissions to fully automated regtech.

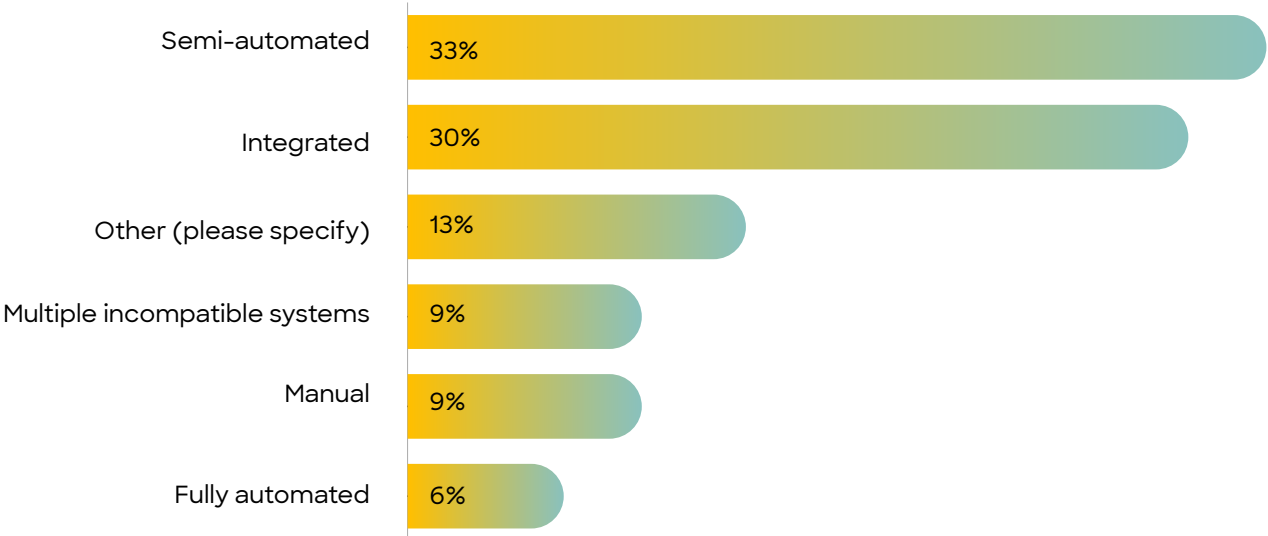
Virtually all supervisory technologies involve a counterparty from which data to be analysed is originally collected. We now turn to the digital capabilities of the banks and other supervised financial institutions sharing the supervisory data. They may submit manually or may use automated

technologies to submit data – so we can view this portion of the analysis as shining a light on the [regtech side of the suptech coin](#).

A narrow majority of supervisory agencies reports that relevant data sources are prepared for submission via semi-automated systems (33.3%), wherein structured data is processed within extract-transform-load (ETL) or extract-load-transform (ELT) data pipelines to transform it into regulatory-required formats for submission. A further 5.6% reported fully automated processing systems, which corresponds with 4G suptech for data processing.

However, 29.6% of respondents indicate they are using integrated, but not automated, data preparation techniques, where records are simply received in various formats across different modules (such as product, customer, core banking, mobile, etc.) and are manually imported, exported, or calculated as needed. This indicates room for improvement by incorporating foundational regtech and suptech into the supervised and supervisors’ collective data stack infrastructure.

FIGURE 26.
WHAT ARE THE GENERAL DATA CAPABILITIES OF THE ENTITIES FROM WHICH DATA ARE COLLECTED? (N=54)

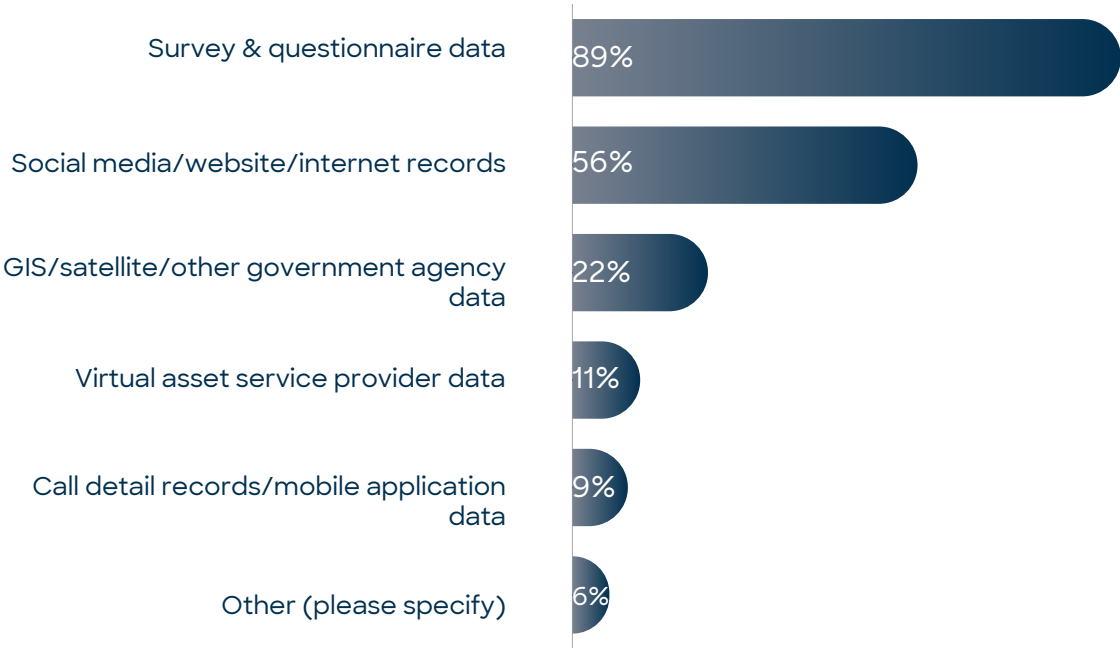


Beyond formal data collection, most financial authorities also leverage surveys, questionnaires, web-based records, and other government data.

In response to the inquiry about alternative data sources pertinent to supervision and intelligence, financial authorities indicated that they administer surveys and questionnaires to source data. Additionally, they gather information from social media, websites, and internet records.

These alternative data sources provide insights beyond traditional financial data, offering a more comprehensive understanding of market trends, consumer behaviour, and potential risks. The inclusion of unstructured data signifies a proactive approach to seeking direct input from relevant stakeholders and reflects the recognition of the value of digital platforms in capturing real-time information for enhanced supervisory and intelligence purposes.

FIGURE 27.
WHICH ALTERNATIVE DATA SOURCES RELEVANT TO SUPERVISION AND INTELLIGENCE ARE COLLECTED? (N=54)



Most agencies are still using early-generation technologies for data collection.

A large proportion of the agencies indicated they use a combination of 0G manual submissions via either digital channels (65%) or physical submissions (24%).

Many are also using 1G upload-based technologies like internally developed web portals (59%), externally developed web portals (41%), and bulk upload systems (41%) to collect data.

Relatively small proportions are using 2G push APIs (30%), 3G pull APIs (2%), or 4G advanced data collection techniques (20%).

FIGURE 28.
FOR THE SUPERVISORY FUNCTIONS YOU SELECTED, THROUGH WHICH CHANNEL(S) IS DATA COLLECTED? (N=54)

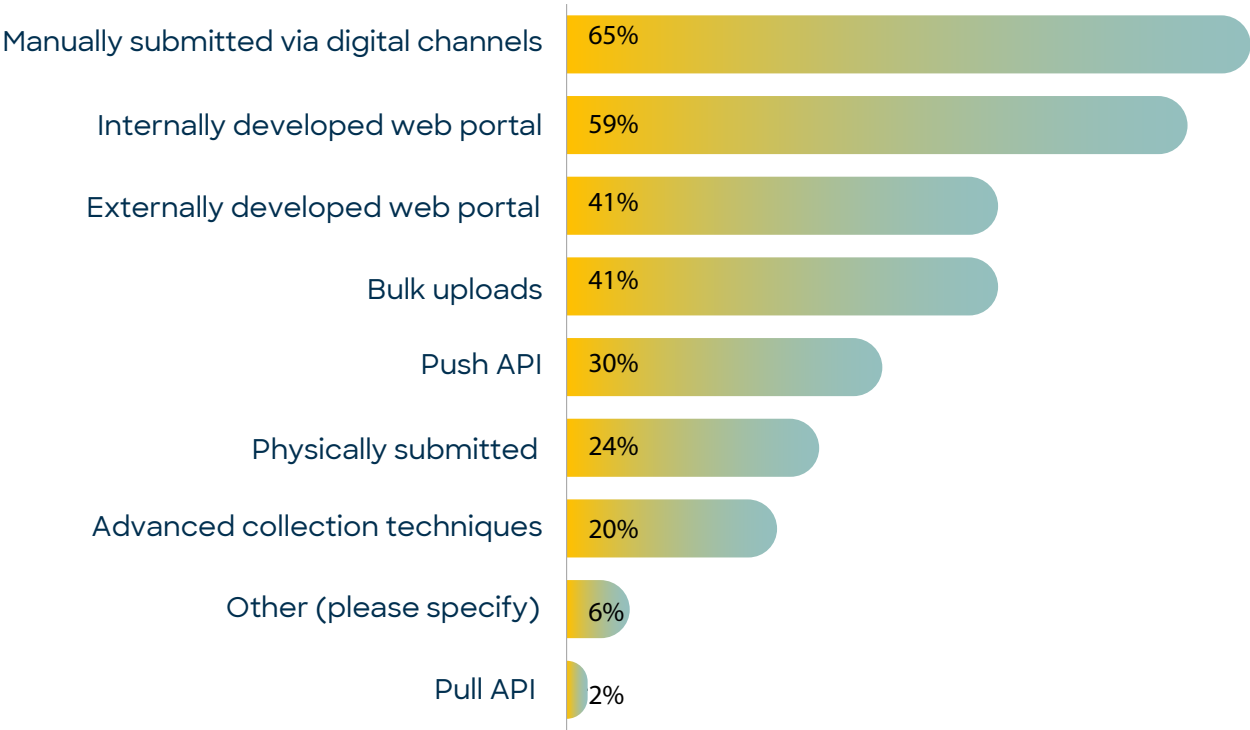
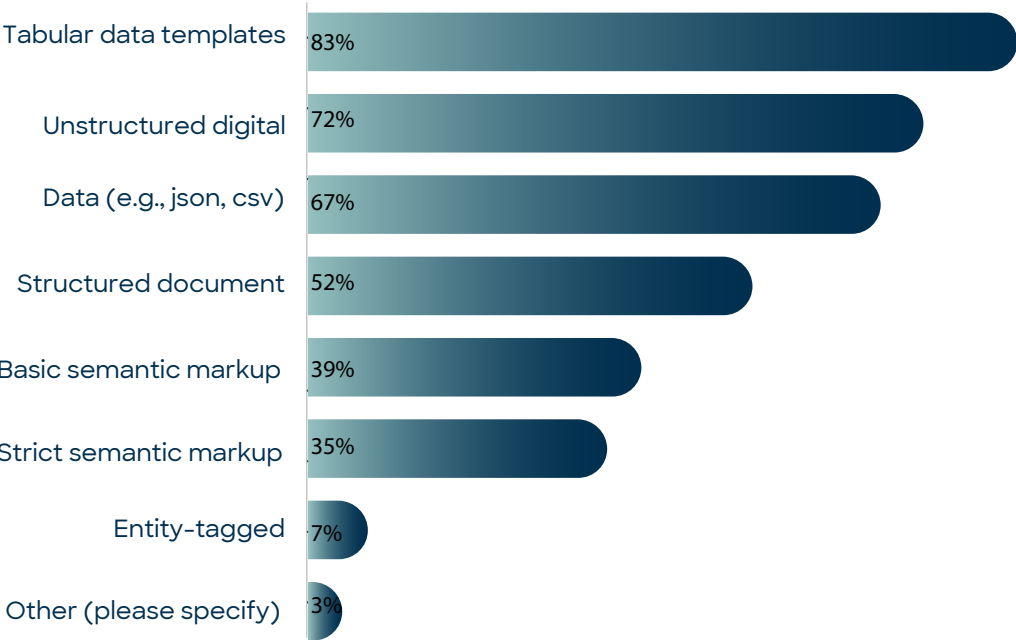


FIGURE 29.
FOR THE SUPERVISORY FUNCTIONS YOU SELECTED, IN WHICH FORMAT(S) IS DIGITAL DATA COLLECTED? (N=54)



The data collected today are most commonly in a format that requires downstream manual processing.

Beyond the largely manual data collection channels, a significant portion of data collection formats also require manual processing by either the supervised financial institution (to prepare and submit the data) or the financial authority (to process and analyse the data).

For example, unstructured digital formats (72.2%) may minimise efforts on the submission side, with the trade off on the supervisory side of increasing the need for manual processing upon receipt.

While tabular data templates (83.3%) introduce some opportunity for automated validation right at the data entry point, they do not guarantee it. Furthermore, data templates often require supervised entities to manually transcribe data from their proprietary systems into, e.g., a spreadsheet, which then needs to

be manually uploaded via a web portal or secure file transfer protocol (SFTP) server. While raw data (66.7%), structured documents (51.9%) and basic semantic markup (38.9%) utilise formats that can be made machine-readable by default, they do not necessarily incorporate validation unless wrapped into an appropriately designed API system, for example.

Conversely, approaches like strict semantic markup (35.2%) like XSD or XBRL can avoid resource-intensive manual processes, reducing demand for human effort and time, making it less prone to errors that can compromise data quality.

3.3.3. Data validation and processing

Data validation most commonly occurs via automated validation. However, manual validation remains prevalent, resulting in human errors and leaving room for further automation.

Financial authorities primarily use automated validation where errors and warnings are integrated into data submission process e.g. validation through APIs (45.3%).

However further 34% opt for manual validation rules applied only after the data

has been received. This approach involves a time-consuming and manual review of excel or the use of static scripts to validate batches of CSV files. Only a small percentage (11.3%) have automated the entire process through scripts, macros or Robotic Process Automation (RPA).

FIGURE 30.
HOW IS DATA VALIDATED? (N=53)

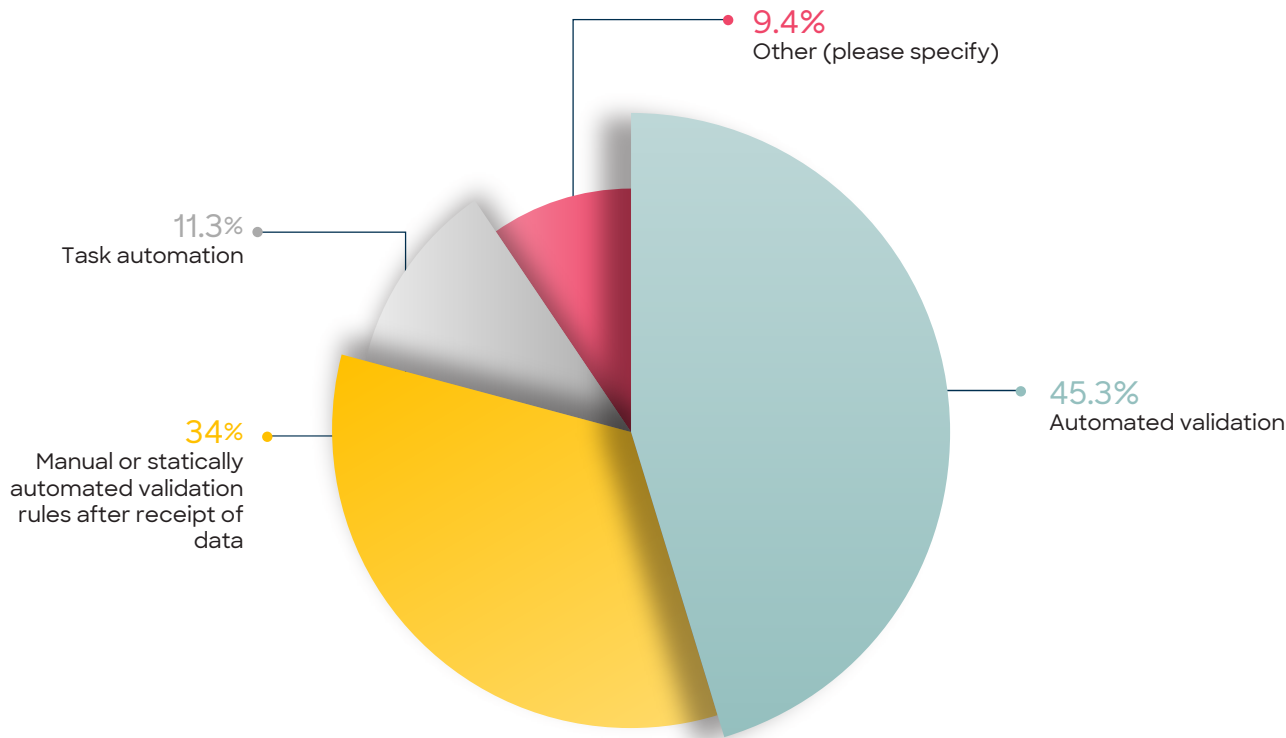


FIGURE 31.
WHAT ARE THE KEY VALIDATION CHALLENGES? (N=53)

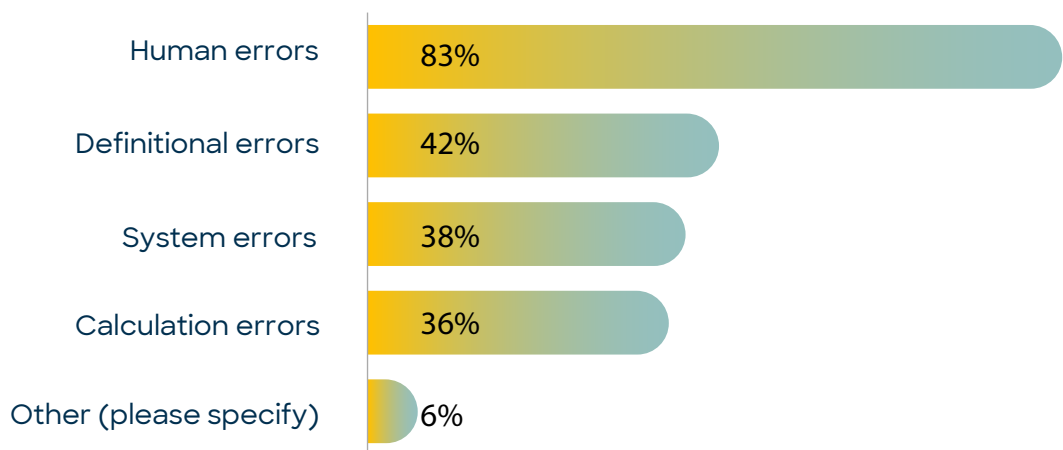
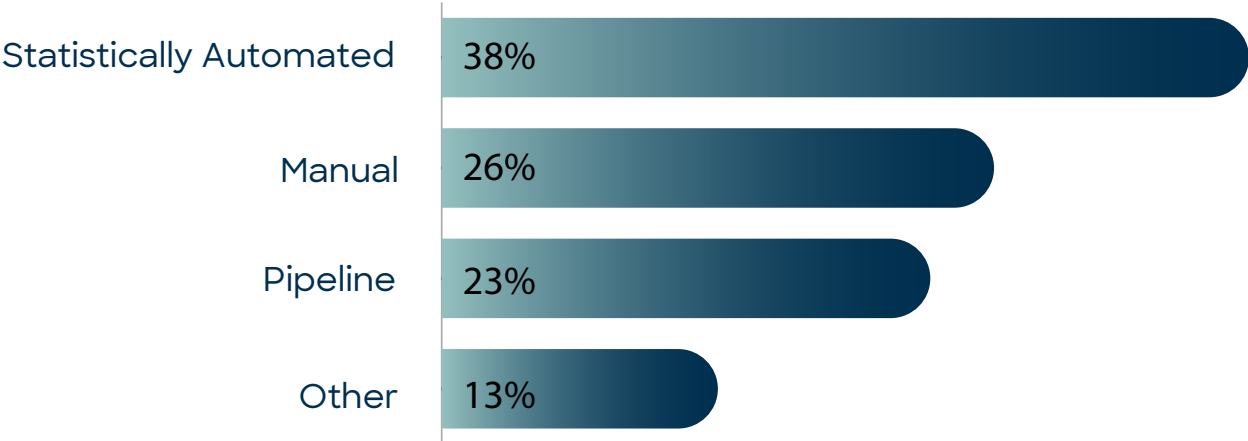


FIGURE 32.
HOW DOES YOUR DATA GET PROCESSED (N=53)



Manual validation processes are prone to errors.

83% of financial authorities report issues with human errors, and 36% have identified calculation errors. APIs, although instrumental in automating validation and reducing errors prior to data submission, require meticulous design and ongoing maintenance. They must be constantly updated to align with evolving supervisory and regulatory requirements to ensure the quality and reliability of the data collected. This necessity is underscored by the fact that 41% of respondents deal with definitional errors, while 38% face challenges due to system errors.

These findings highlight the need for a robust design and support for APIs to effectively handle the complex and dynamic nature of financial data validation.

Data processing most commonly occurs via statically automated scripting and manual processes, leaving room for more dynamic and extensive automation.

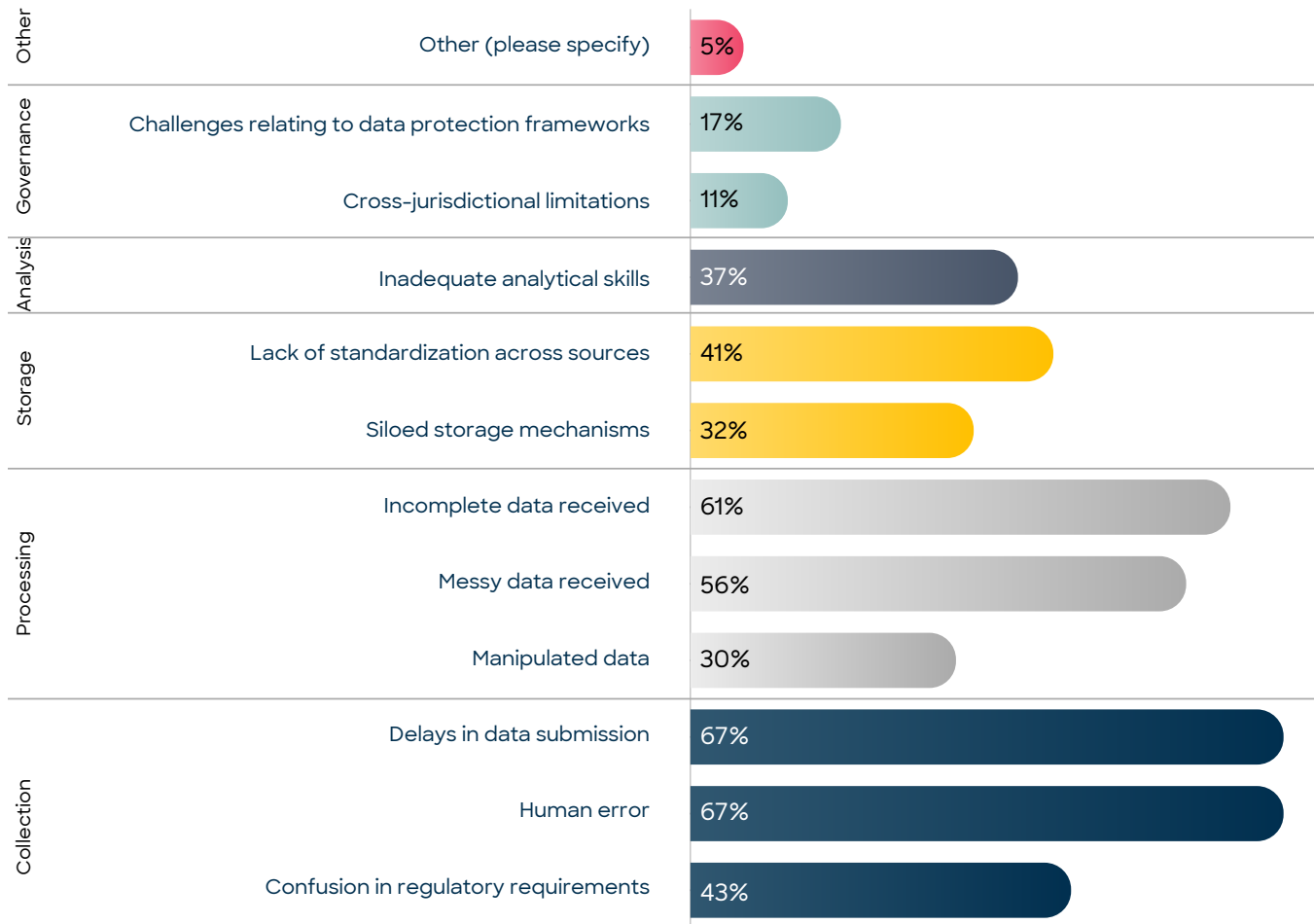
Financial authorities primarily utilise a statically automated approach, employing spreadsheet macros, robotic process automation (RPA), and basic scripts (37.7%).

Additionally, 26.4% opt for a manual data processing method, involving human intervention for tasks like integration, file movement, and data entry. While less automated, this manual approach is suitable for tasks requiring a nuanced human touch or scenarios where full automation is not as feasible. However, it may be more time consuming and prone to errors compared to fully automated processes.

Another 22.6% adopt the pipeline method, utilising APIs for data movement, synchronous ETL processes, and microservices, allowing for automated and asynchronous data processing (e.g., DataStreams).

FIGURE 33.

WHAT ARE THE CHALLENGES YOU FACE USING DATA RELATING TO THE SUPERVISORY FUNCTIONS YOU SELECTED ABOVE? (N=54)



The prevalence of manual data collection, validation and processing mechanisms leads to downstream challenges in making full use of the collected data.

In alignment with the earlier generation data processing technologies, financial authorities noted difficulties encountered in utilising collected data for various functions. Key challenges typically associated with manual treatment emerge, encompassing issues such as delays in data submission (67%) and human errors (67%).

Suptech solutions for automating data validation and processing rules are critical components of addressing these painful challenges and ensuring sufficient data quality. Yet defining technical requirements for validation rules and processing specifications is a step that's often overlooked while working toward advanced, supervisor-facing solutions focused on user interfaces for analytics and other data products.

At minimum, supervisory authorities should take care to engage a technologist in considering such specifications as part of the broader data stack underlying a given solution."

3.3.4. Data storage and governance

Data is most frequently stored via on-premises servers and individual computers, which are less scalable, more siloed, and more susceptible to cybersecurity issues than cloud-based systems.

Financial authorities predominantly store their data in-house (68.5%) or utilising dedicated or private servers (51.9%) over

cloud storage (31.5%). This approach underscores a preference – and very often a mandate – for maintaining control and security over sensitive financial information. Mitigating cyber risk means the cloud is simply not an option for perpetual data storage.

Upgrading data storage from siloed mechanism to individual computers (35.2%) is a priority to mitigate risks related to cyber vulnerabilities, data loss, and inefficiencies in data processing across the agency.

FIGURE 34.
WHERE IS THE DATA CURRENTLY HOSTED? (N=54)

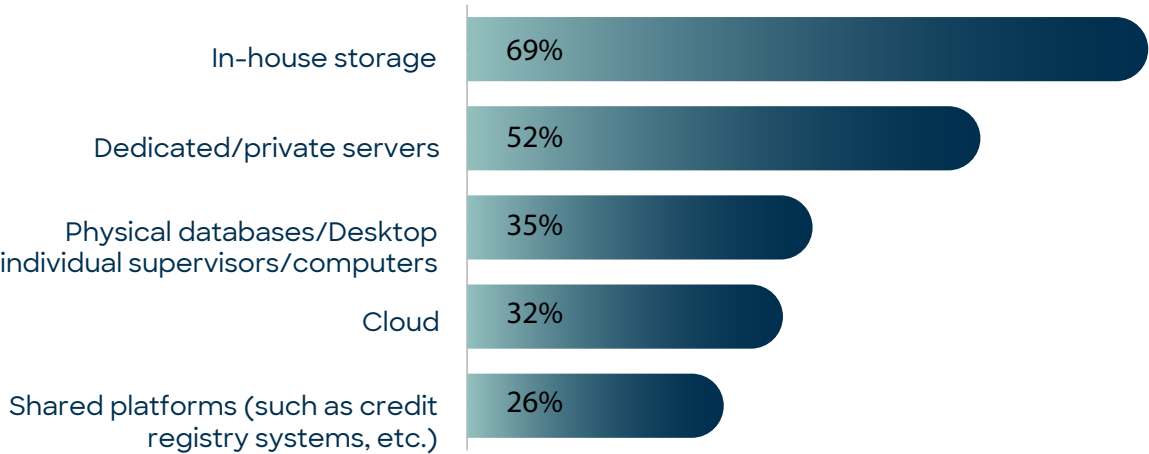


FIGURE 35.
WHICH FACTORS DOES YOUR ORGANIZATION CONSIDER MOST APPLICABLE IN ASSESSING CLOUD-BASED COMPUTING OR STORAGE SERVICES? (N=54)

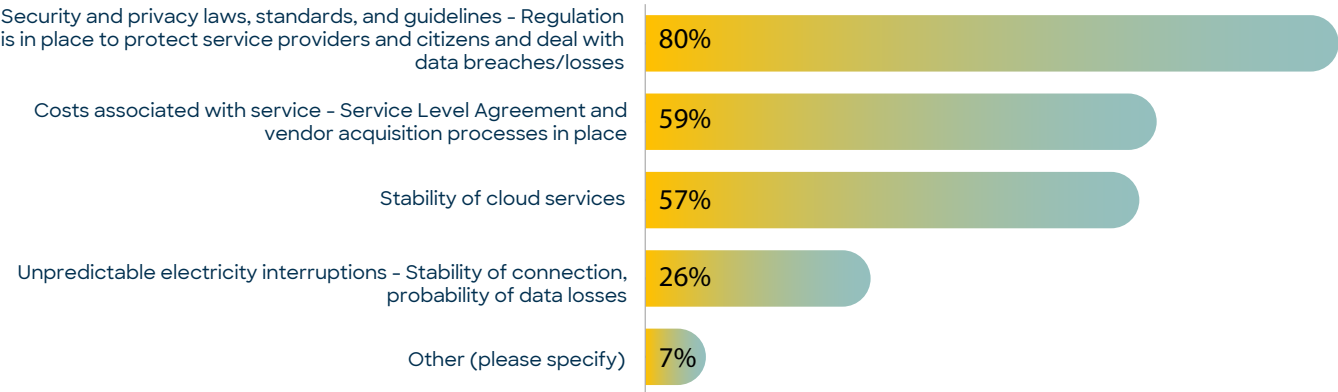
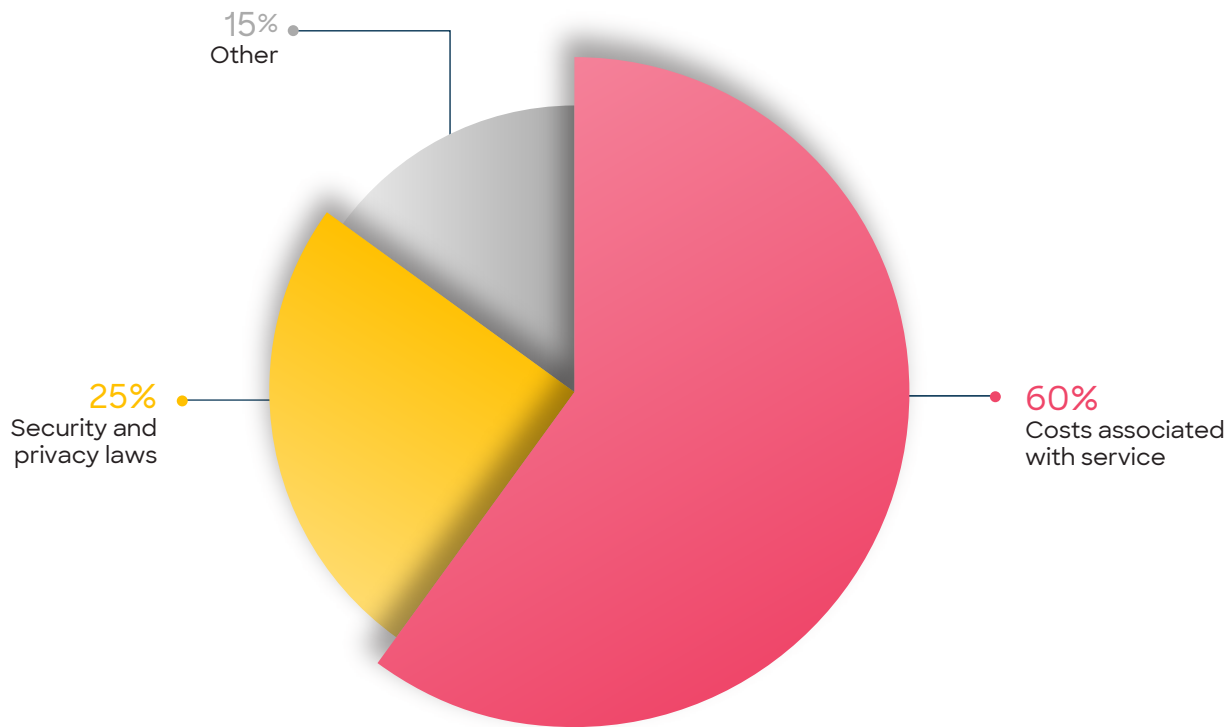


FIGURE 36.

MAIN CONCERNS REGARDING CLOUD-BASED STORAGE PROVIDED BY RESPONDENTS WHO DO NOT CURRENTLY USE CLOUD-BASED SERVICES



Concerns associated with leveraging cloud storage services centre primarily around costs.

The majority's preference for in-house solutions may be driven by expressed concerns related to security and privacy requirements (79.6%), associated costs (59.3%) and suitability of cloud services (57.4%), and reliability (25.9%). Whether this is a matter of perception or the reality, it appears incumbent upon cloud providers to engage with financial authorities to address these concerns.

Of the respondents who do not use cloud-based solutions for storage, almost 60% indicated that the costs associated with implementation of cloud storage was an inhibiting factor. A further 25% also expressed concerns regarding security and privacy laws.

With the advent of higher volumes of more complex data, data warehouses are now nearly as frequently adopted as traditional database systems.

Financial authorities primarily rely on relational database management systems (RDBMS) (36%) and data warehouses (32%) as their main storage repositories. The choice of RDBMS and data warehouses suggests a commitment to maintaining structured, organised, and query-friendly storage solutions, essential for the complex and interrelated nature of financial data.

However, authorities continue to explore the mining of semi-structured and unstructured data like scanned PDFs, text from onsite visit reports, and bodies of social media posts, and they may introduce tools to store the resulting supervisory insights. With this trend, tools like data lakes (13.6%) and data marts (13.6%) may become more prevalent.

FIGURE 37.
WHICH STORAGE
RESPOSITORIES ARE
BEING USED?
(N=22)

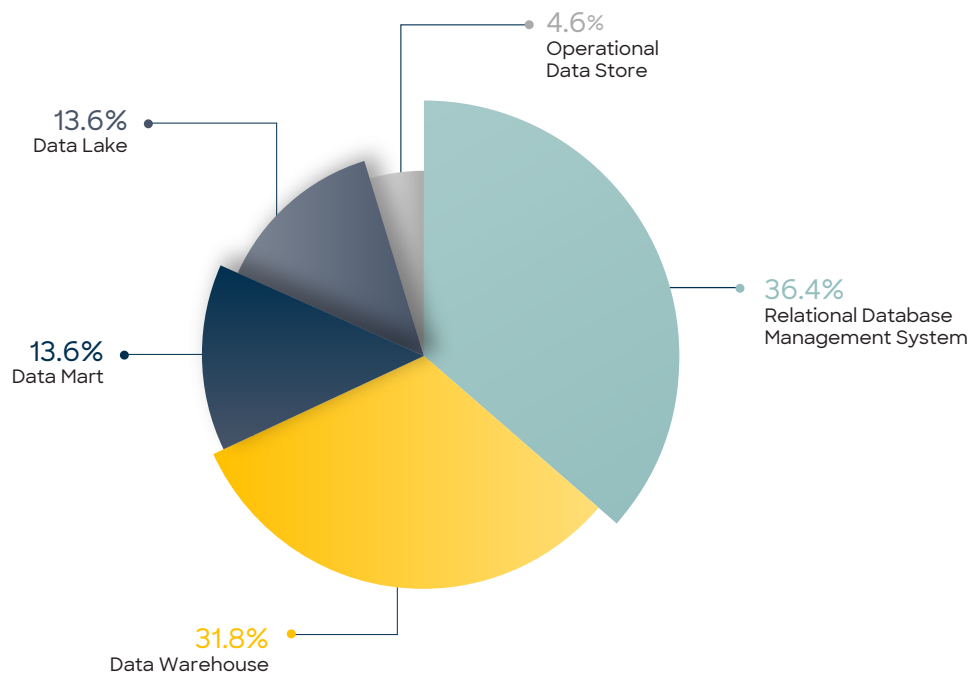
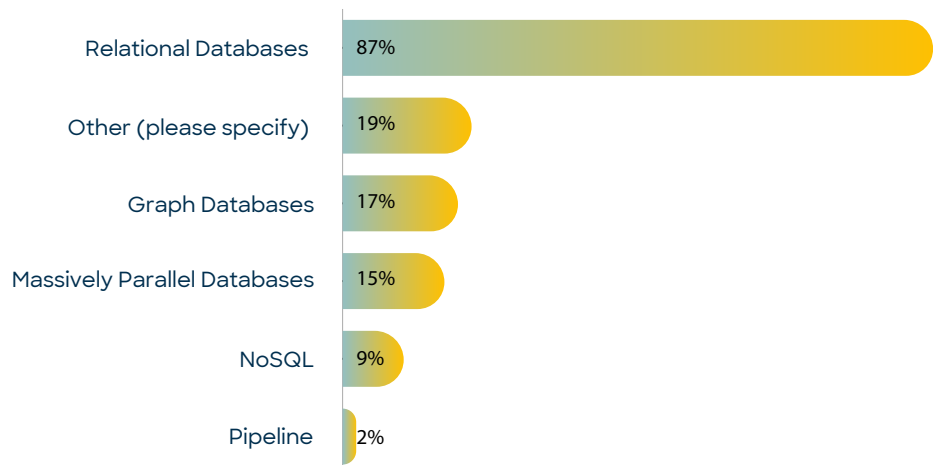


FIGURE 38.
WHICH SOFTWARE
TOOLS ARE BEING
USED FOR STORAGE?
(N=53)



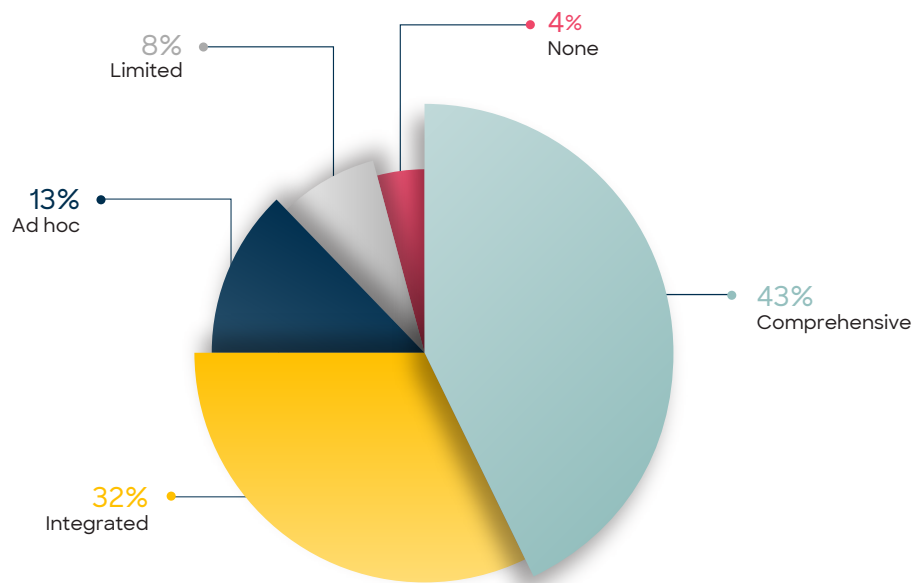
While relational databases dominate the technology underlying databases, data warehouses, data marts, and data lakes, specialised databases are also appearing on the scene.

Given the current tendency toward structured, relational data, naturally the vast majority (86.8%) of software tools used for storage are Relational Databases, e.g., PostgreSQL, SQLServer, and Oracle. While specialised databases such as graph databases (17%) are currently less common, the acceleration of

research on the value of network analysis for supervisory activities (e.g., money laundering detection, prudential contagion risk, and payments fraud) may lead to increases here.

Additionally, with the emergence of AI foundational models – such as LLMs for quantifying textual data – in the supervisory space, it would be expected to see corresponding data storage mechanisms such as vector databases feature more prominently on this list in subsequent surveys.

FIGURE 39.
WHAT PRIVACY
AND DATA PROTECTION
POLICIES ARE IN PLACE?
(N=53)



Nearly all authorities have some form of data governance in place, but there is room for more comprehensive and integrated approaches.

The commitment to data governance is evident, with 75% of financial authorities implementing privacy and data protection frameworks. A notable 43.4% of these authorities employ comprehensive policies covering all data lifecycle stages, ensuring meticulous management of data from its collection to eventual deletion, which points to attention paid to securing sensitive information. Additionally, 32.1% of authorities adopt an integrated approach, harmonising their broad data policies with ethical guidelines and training programs for personnel, enhancing the safeguarding of data integrity.

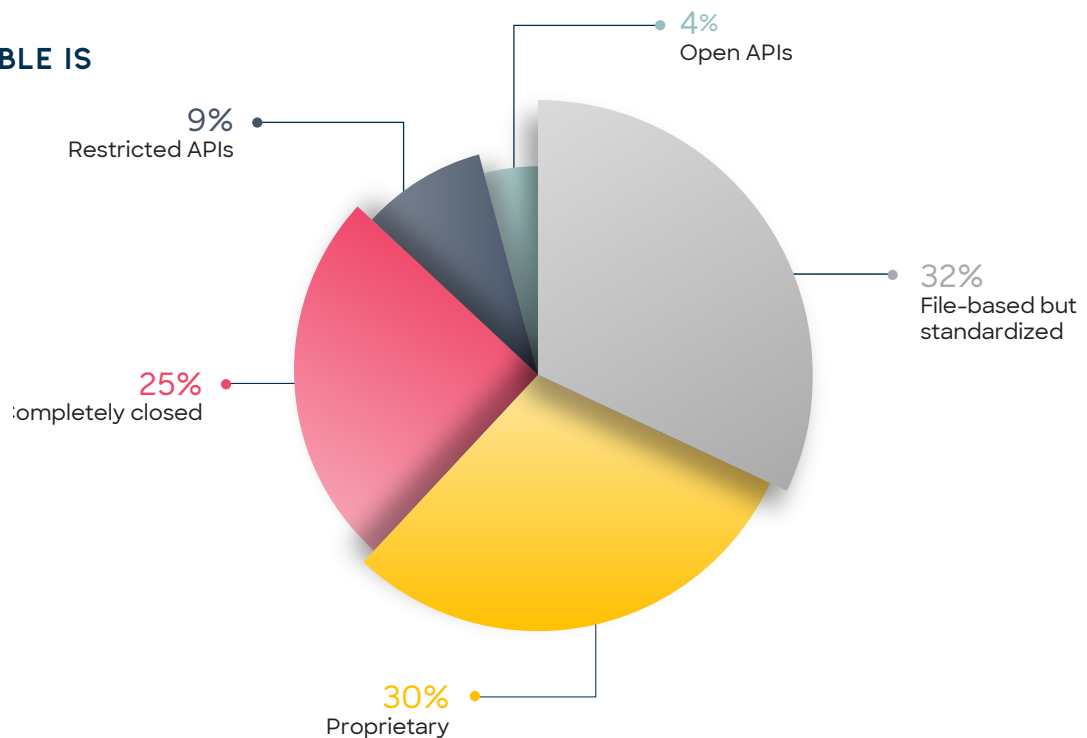
There is, however, room for improvement. Nearly 8% of authorities possess only basic data privacy frameworks, and approximately 4% lack any formal policy. Opportunities for safe and frank discussions and cross-pollination of lessons, practices and tools could aid in bringing these figures to a minimum. Global data governance forums and regulatory technology conferences could serve as platforms for sharing best practices and bolstering standards among all authorities. For example, the Global

Privacy Assembly (GPA) offers resources and collaborative opportunities for enhancing privacy frameworks. Similarly, the International Conference of Data Protection and Privacy Commissioners (ICDPPC) is a forum for data protection authorities to discuss and develop privacy standards that could be applied by financial authorities as well. These international efforts, alongside techsprints and hackathons, could be instrumental in addressing existing deficiencies and guiding authorities towards more robust data governance structures.

Overall these figures indicate these critical issues are being addressed by the majority of responding authorities, however, subsequent deeper dives into the existing policies would be illuminating in examining their robustness and integrity.

For further insight, reports like the Financial Stability Board's (FSB) "[Artificial Intelligence and Machine Learning in Financial Services](#)" discuss the importance of data quality and governance in financial supervision. Additionally, the Basel Committee on Banking Supervision (BCBS) provides [guidelines](#) on data governance and expectations for data quality across financial institutions, offering a framework that supervisory authorities might model their practices after.

FIGURE 40.
HOW ACCESSIBLE IS
THE DATA?
(N=53)



3.3.5. Data access and analysis

Data access remains largely via file-based and closed systems, which risk limiting supervisors' ability to draw deep insights from across multiple datasets.

Turning to data access for financial supervisory authorities, only 13.2% of stored data is available via either restricted or open APIs. Despite the massive efficiencies long demonstrated by the use of such tools in moving data, the adoption is remarkably low. In absence of such systems, visibility of supervised entities is restricted to data submitted through standardised file-based, proprietary, or closed systems, limiting supervisory oversight.

32.1% of financial authorities' access to data is file-based, indicating that information is organised and stored in various file formats. This approach allows for the structured management of data files, accommodating specific analyses or processing tasks. The access is

standardised, implying consistency and agreed-upon protocols for data retrieval and handling, promoting interoperability. The remaining 54% report either significantly restricted or even completely closed access to data.

30.2% report that there is a proprietary aspect to the access methods, suggesting exclusivity to certain systems or technologies. This proprietary nature may pose challenges in terms of compatibility with external systems.

A further 24.5% report that the access approach is described as completely closed, signalling restrictions on external entities or systems. While this closed access enhances security and confidentiality, it may limit the potential for integration with external technologies and collaborative data sharing.

In the context of supotech, these characteristics highlight the need for financial authorities to carefully balance security considerations with the imperative for interoperability to foster innovation and collaboration.

The vast majority of respondents report collecting only data they are using, honoring a key tenet of data governance.

The landscape of financial supervision reflects a promising trend, with over half of the authorities (50.9%) affirming the adequacy of their data for analytical endeavours. This not only suggests an appropriate level of granularity in their data collection but also underscores the ethical considerations ingrained in their analytical practices.

A proactive 26.4% of authorities takes this one step further, actively engaging in periodic reviews of their data management practices, ensuring alignment with global standards and best practices. This commitment to excellence is further exemplified by the 5.7% that meticulously align their data collection with specifically designed indicators, ensuring each dataset serves a definitive supervisory purpose.

Altogether, these statistics reveal that an overwhelming majority (83%) are not just gathering data but also actively utilising

FIGURE 41.
WHAT IS THE USEFULNESS OF THE DATA GIVEN THE LEVEL OF GRANULARITY FOR THE DATA SOURCES? (N=53)

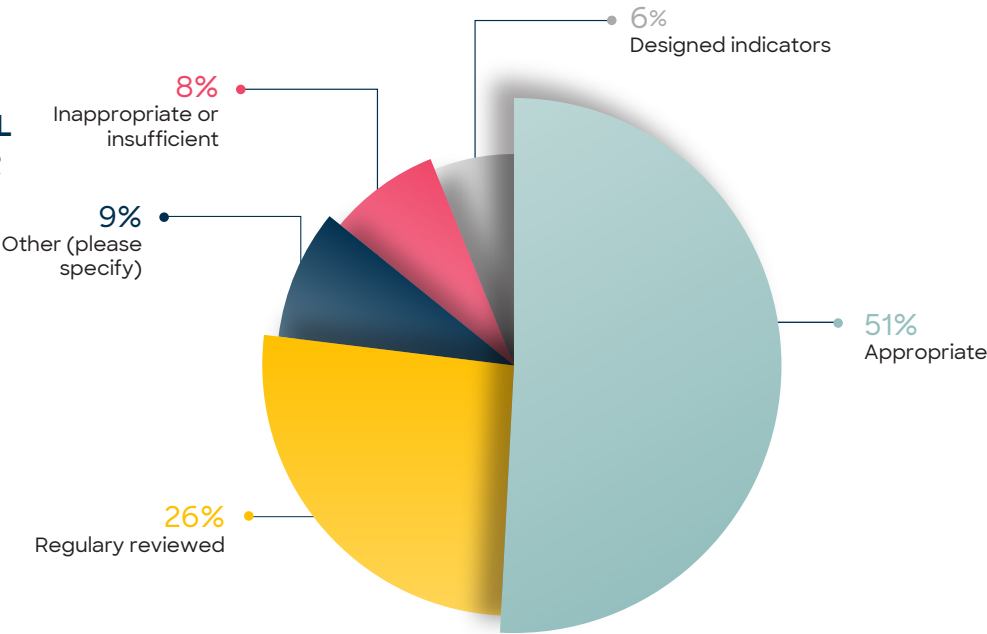
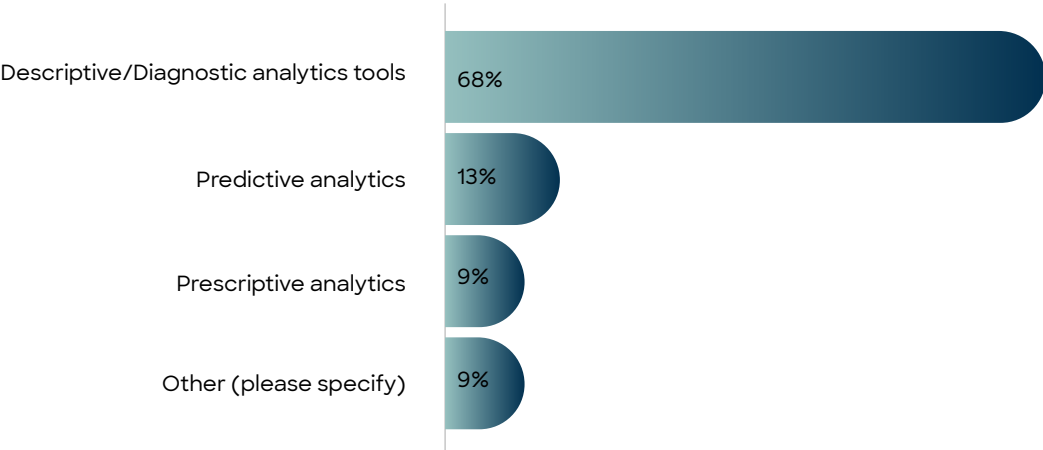


FIGURE 42.
WHAT TYPE OF ANALYTICS ARE CONDUCTED? (N=53)



it to inform their supervisory activities. This is an encouraging sign that points to maturing data governance within the agencies.

Conversely, the remaining 7.6% signal a gap in data collection, possibly due to limitations in technological infrastructure, regulatory mandates, or data collection methodologies. Addressing these gaps is essential for bolstering the comprehensiveness of supervisory oversight.

Data analysis remains largely descriptive or diagnostic.

68% of financial authorities utilise 1G descriptive or diagnostic tools, such as data visualisation in shared files or browser-accessible dashboards, for data analysis. In contrast, a mere 13% make use of 2G predictive analytics tools, such as machine learning, network analysis, or other modelling techniques. An even smaller portion (9%) applies 4G prescriptive analytics to generate actionable recommendations.

3.3.6.Data products

Rather than modern data science tooling, most respondents use static charts and metrics to draw insights from their data, limiting the ability to interrogate data beyond descriptive summaries and search.

The majority of financial authorities (57%) have implemented reporting mechanisms centred around static charts and metrics and a few of them (24.5%) have embraced more dynamic reporting through interactive visualisations. Less than 8% are using advanced business intelligence tools.

Finally, in terms of the tools used for ultimately surfacing the analytics as data products to the end users (i.e., supervisors), the majority of financial authorities leverage Business Intelligence (BI) and visualisation analytical tools to optimise their data reporting processes (54.7%). These tools include, for example, Tableau, PowerBI, and SAS visual analytics.

FIGURE 43.
WHAT TYPE OF REPORTING IS IN PLACE? (N=33)

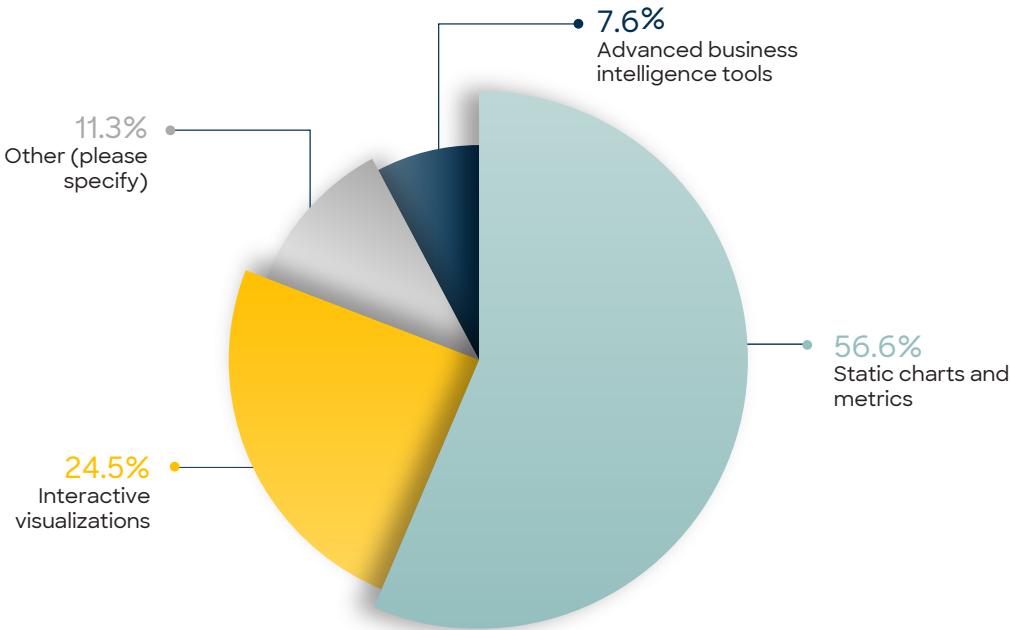
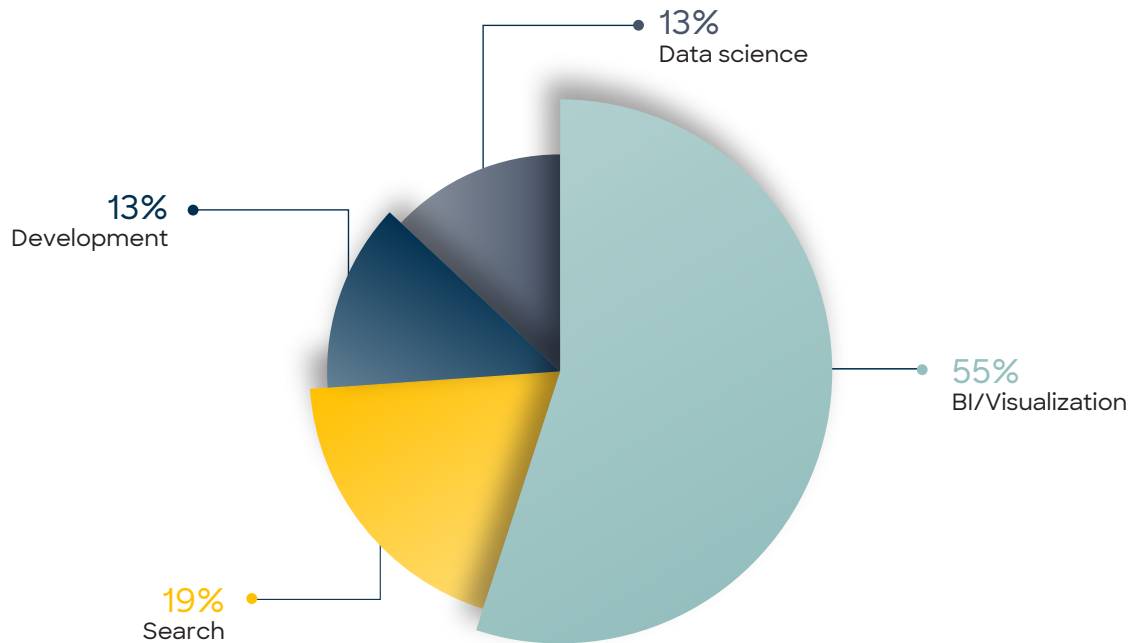


FIGURE 44.

WHAT TYPE OF ANALYTICAL TOOLS ARE USED TO OPTIMIZE DATA REPORTING? (N=53)



Beyond BI/visualisations, nearly 20% of the tools have produced some form of search, such as the open source ElasticSearch software. A further 13.2% leverage traditional programming to automate the production of data products for supervisors and other stakeholders.

Only 13.2% are using traditional data science tools from Python, R, or Apache Spark to extract deeper insights from the analysis.

3.3.7. Digital supervisory infrastructure

While viewing each layer of the supervisory data stack can be useful for assessing progress at each stage to inform modular treatment, it is also crucially important to conduct a more holistic stocktaking of technologies used across all layers.

From cutting-edge data analytics to AI-driven solutions, this section summarises the digital supervisory infrastructure that supports the different suptech use cases.

Embracing the Cambridge SupTech Lab's comprehensive SupTech Taxonomy (Appendix 2), the approach elaborated upon in this section seeks to establish a structured framework that facilitates a nuanced analysis and fosters a deeper understanding of the intricate interplay between supervisory functions and technological solutions.

Through this categorisation, we aim to offer a systematic lens that enables stakeholders to navigate the evolving suptech landscape with increased clarity and accuracy.

FIGURE 45.

WHAT UNDERPINNING TECHNOLOGIES DOES YOUR AGENCY USE TO ENABLE SUPERVISORY PROCESSES? (N=53)

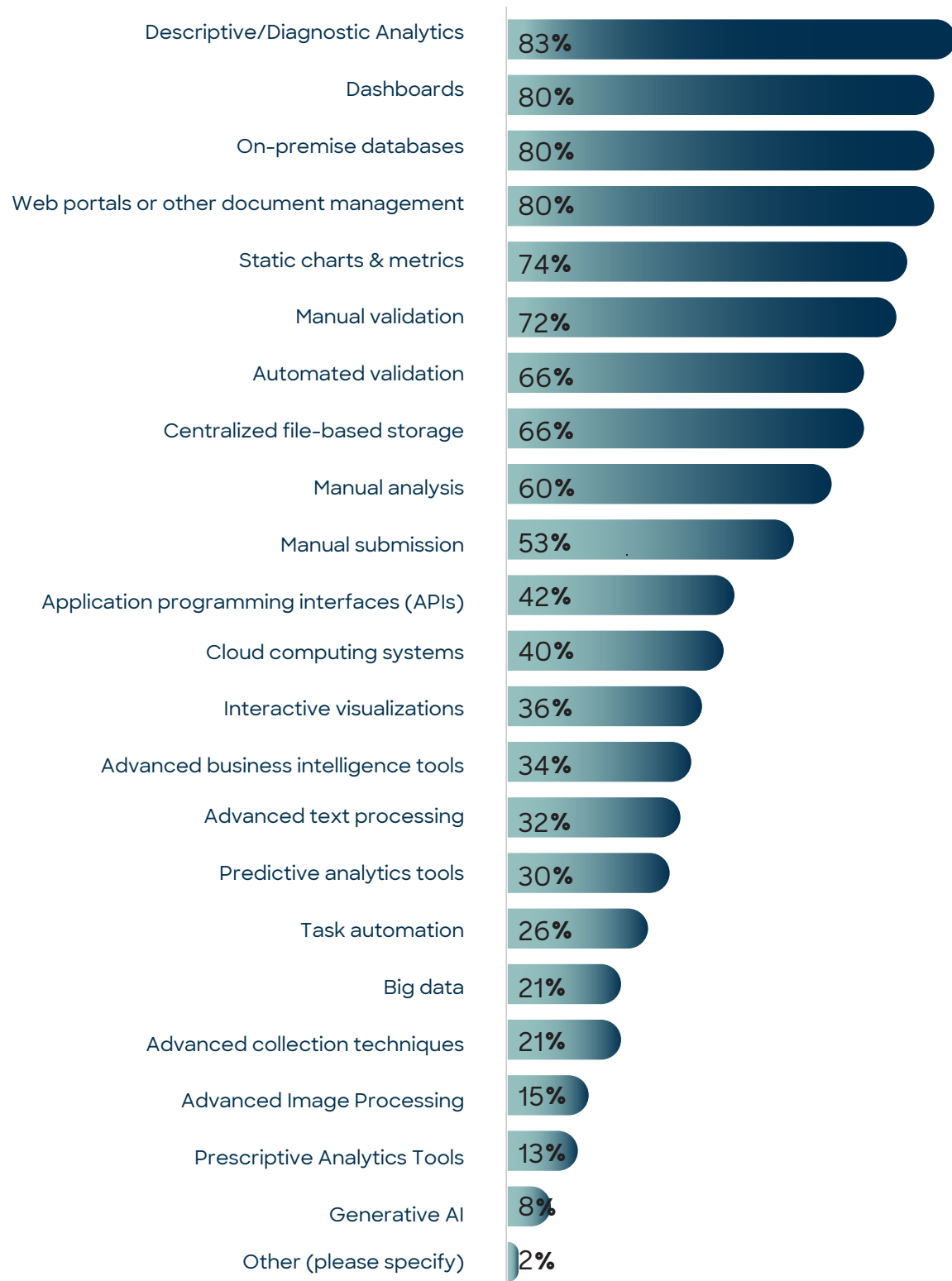
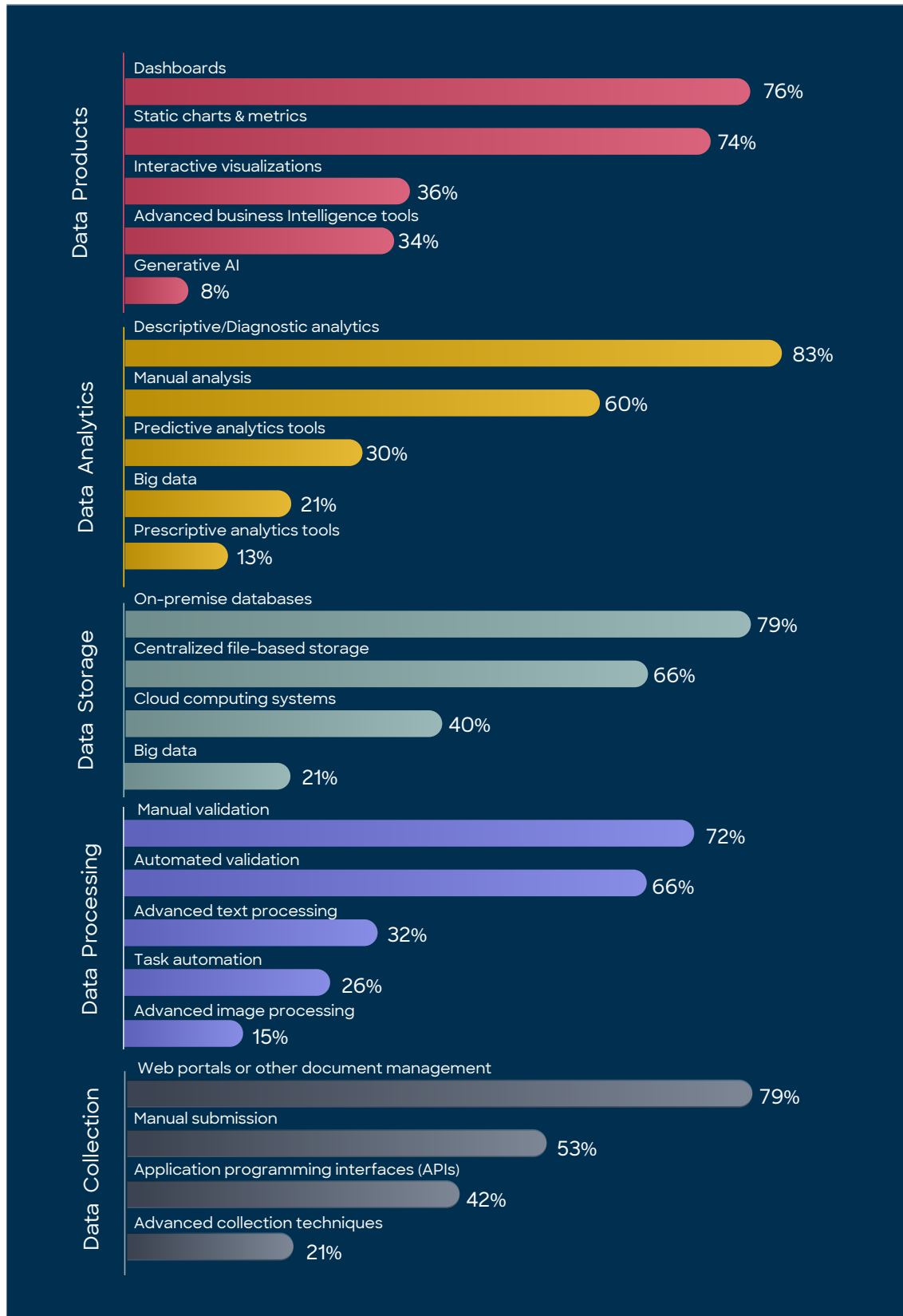


FIGURE 46.

WHAT UNDERPINNING TECHNOLOGIES DOES YOUR AGENCY USE TO ENABLE SUPERVISORY PROCESSES? (N=53)

ACCORDING TO THE SUPERVISORY STACK LAYERS OF THE SUPTECH TAXONOMY



The top technologies incorporated into a digital supervisory infrastructure remain early-generation, including descriptive analytics, dashboards, relational databases, and web portals.

Similar to last year, the utilisation of early-generation (1G/2G) technologies such as descriptive analytics (83%), dashboards, on-premise relational databases, and web portals (79.3%) and static reports (73.6%) by financial authorities continue to serve as a foundational infrastructure in enhancing data quality and management, and overall efficiency of supervisory processes.

Generative AI has also entered the suptech scene.

It is noteworthy that this year, 7.6% of the respondents reported the introduction of Generative AI (GenAI) technology as a form of 4G suptech. While still in its nascent stage, GenAI has shown a lot of promise in handling extensive and varied datasets, along with its capability to produce content in user-friendly formats, including conversational interfaces, is significantly contributing to increased efficiency and enhanced customer experiences, as well as improved risk mitigation and compliance reporting within the financial sector. Examples of GenAI applications in suptech is leveraging LLMs to draft code, summarise documents prepared by supervised banks, and enhance communication clarity.

The European Central Bank (ECB) has revealed [plans](#) to explore technology akin to ChatGPT for various applications in banking supervision and highlighted the potential of these models in summarising documents, drafting briefings, and improving internal communication.

Nevertheless, the incorporation of GenAI in financial operations comes with

inherent risks that demand thorough comprehension and proactive [mitigation efforts](#) from both the industry and prudential oversight authorities. [These issues encompass](#) embedded bias and privacy vulnerabilities, lack of transparency regarding outcome generation, concerns about robustness, cybersecurity risks, and the broader impact of AI on financial stability.

3.3.8. Transformation through the lens of the SupTech Generations

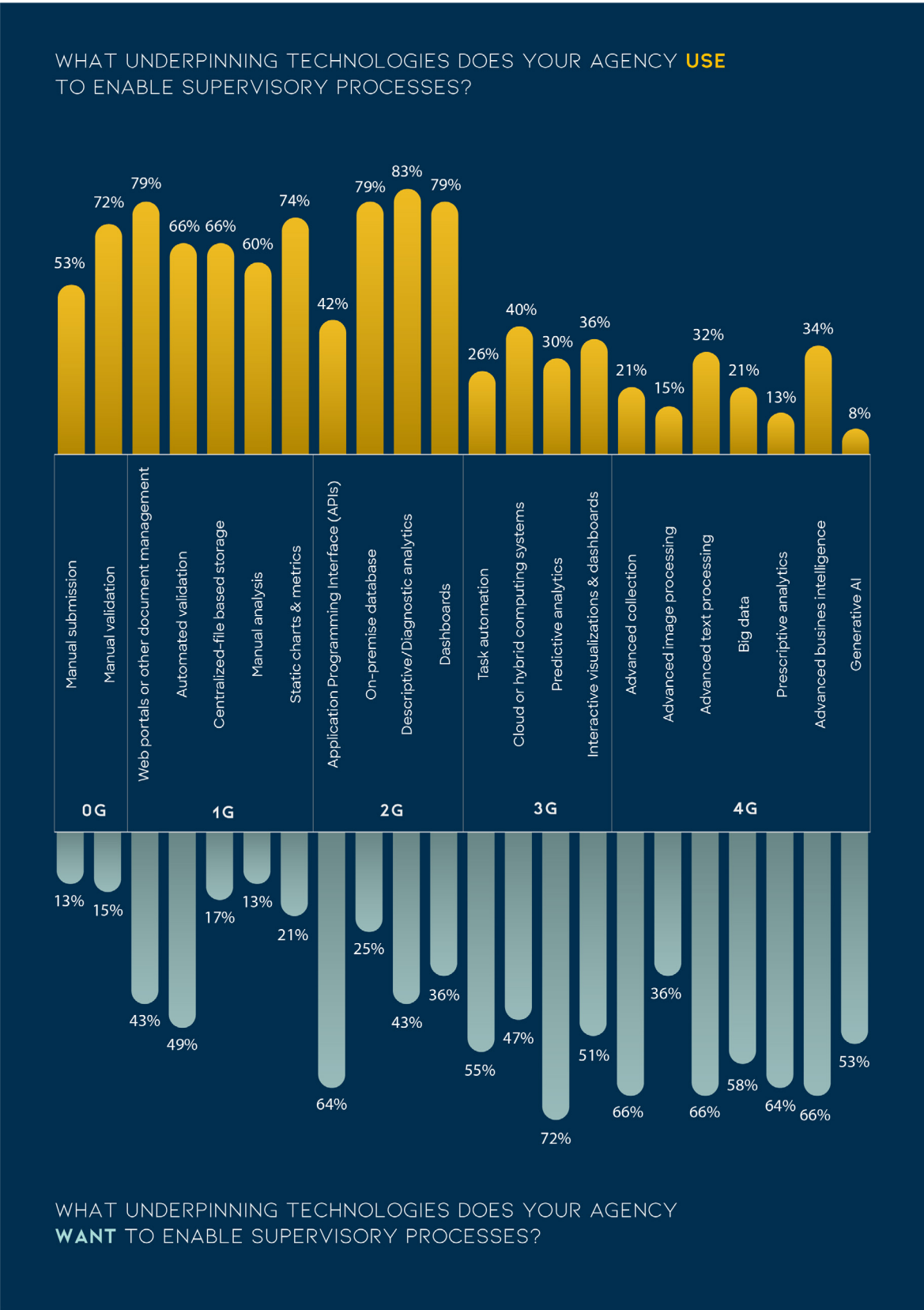
Despite the progress made in the last year, the bulk of the deployed suptech tools still falls into the first (1G) or second (2G) generations of suptech, which mainly support descriptive and diagnostic analytics. Demand for the most advanced 3G and 4G technologies remains high.

The assessment of the existing supervisory infrastructure in relation to the SupTech Generations (see section 2.4) reveals that financial authorities are still situated in the early 1G/2G phases of the Suptech Generations continuum.

The aspiration of financial authorities to evolve from traditional analytical methods to the advanced 3G/4G suptech strata is notable. This ambition was prominently featured in last year's State of SupTech Report 2022 and has been emphatically confirmed by the data from this year's survey.

As financial authorities delve into the realm of suptech, however, they continue to encounter persistent obstacles that impede their transition into the more sophisticated tiers of the technology. Challenges such as entrenched legacy IT systems, nascent data analytics capabilities, and stringent budgetary constraints are slowing down their progress toward the adoption of advanced 3G/4G suptech layers (see section 3.6).

FIGURE 47.
UNDERPINNING TECHNOLOGIES USED VERSUS DESIRED BY AGENCIES TO ENABLE
SUPERVISORY PROCESSES (N=53)
 ORGANIZED BY SUPTECH GENERATION



This persistent adherence to 1G/2G technology may also shed light on the reason financial authorities, especially those in EMDEs, report that their current use of suptech primarily enhances the speed and efficiency of supervisory activities, rather than uncovering groundbreaking insights and more about streamlining existing processes and oversight functions.

The growing demand for the latest generations of supervisory technology, equipped with artificial intelligence, machine learning, and advanced analytics, signifies the sector's push to transcend traditional analytical methods to deploy predictive analytics, elevated business intelligence, and refined data collection techniques. This trend toward a forward-looking, nuanced approach in supervision reflects the strategic imperatives to more dynamic and insightful regulatory oversight.

Financial authorities have expressed their inclination toward these advancements, particularly emphasising the desire for tools such as predictive analytics (72%), advanced business intelligence (66%), and advanced text processing (66%), advanced business intelligence (66%), and advanced data collection techniques like web and social media collection (66%) to bolster their suptech capabilities.

These prioritised “wants” represent a slight shift from the previous year. The State of SupTech Report 2022 reported that authorities at that time prioritised prescriptive analytics (86%), task automation (81%), advanced image processing (79%), predictive analytics (78%), and advanced data collection techniques like web and social media collection (74%).

To translate these expressed desires into tangible reality, financial authorities can take a structured approach. Initiating a comprehensive assessment of current

technological capabilities lays the groundwork, providing insights into existing strengths and weaknesses. Clear objectives and use cases should be defined to pinpoint where these advanced technologies can offer the most value in supervisory functions.

Investing in skill and capacity building becomes paramount, ensuring that supervisory staff is well-equipped to understand, implement, and manage these sophisticated tools.

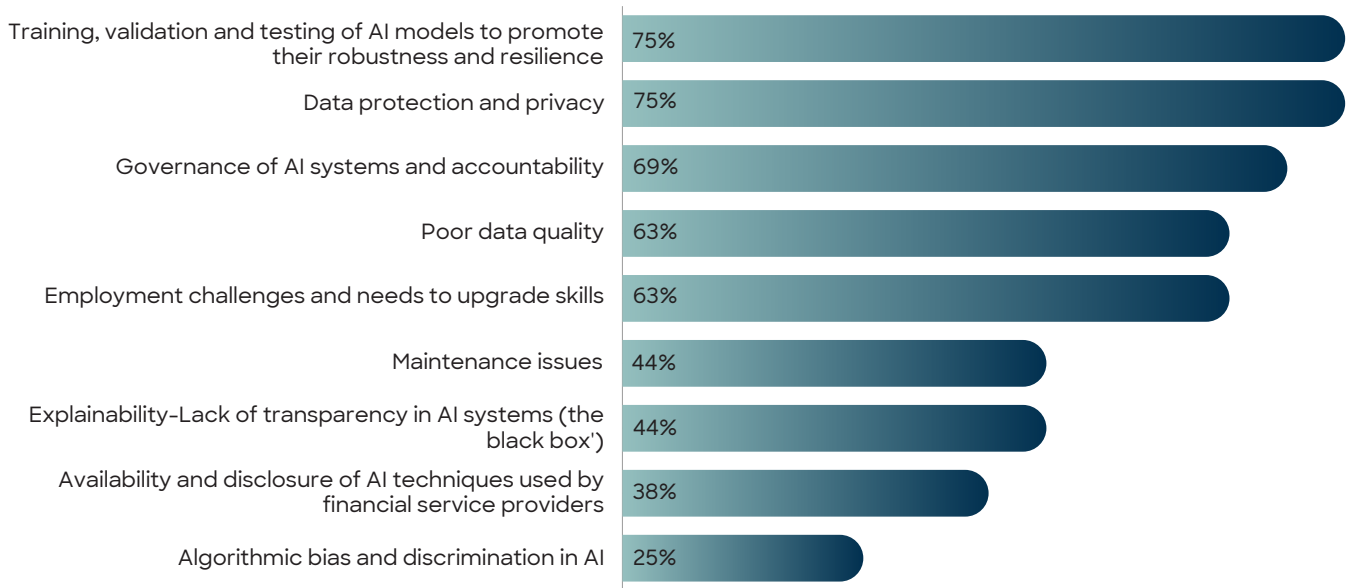
Collaboration with industry experts, academia, and vendors can help to develop the methodologies to extract the most valuable insights from 3G/4G tools, as well as to developing robust frameworks to address ethical, legal, and privacy considerations.

Pilot initiatives allow financial authorities to test the feasibility and effectiveness of the desired technologies in controlled environments. They offer key insights to refine approaches and inform comprehensive iterative implementation strategies that scale up these innovations gradually, including solid change management and continuous evaluation to facilitate a nimble and well-tuned integration.

Prioritising data quality and governance, cybersecurity measures, and designing scalable and flexible technology infrastructure are integral components of the actualisation process. In this way, financial authorities can seamlessly transition from expressing a desire for advanced suptech tools to effectively deploying them into their supervisory functions, enhancing overall capabilities to address the changing demands of financial supervision in the modern, dynamic financial landscape.

FIGURE 48.

WHAT CHALLENGES DOES THE AGENCY FACE WITH THE DEPLOYMENT OF ARTIFICIAL INTELLIGENCE (AI)? (N=16)



As financial authorities chart their course from initial suptech implementations towards the deployment of AI, they face a diverse set of challenges. These not only include the development of fair and transparent machine learning models but also extend to overarching governance of AI, persistent data quality issues, and the lack of expertise in this area.

Among those respondents that have incorporated AI into their supervisory processes (35%), a substantial majority highlight the rigorous demands of training, validating, and testing AI models. This ensures their effectiveness and reliability for complex financial oversight tasks (75%). Capacity-building initiatives – such as the Lab’s [Practical Data Science in Financial Supervision](#) and the European University Institute’s [Supervisory Digital Finance Academy](#) – are instrumental in addressing these needs. Complementary

tools such as the Lab’s forthcoming Data Gymnasium provide practical platforms for hands-on experimentation with real anonymised or synthetic data sets.

Data governance takes center stage, with a strong focus on protecting sensitive financial information. 75% of respondents acknowledge data protection and privacy as paramount concerns, necessitating robust safeguards. Additionally, 62.5% of the authorities cite subpar data quality as a significant barrier, underscoring the necessity of meticulous data curation to ensure the accuracy and reliability of AI-powered systems.

Furthermore, the administration of AI systems calls for the establishment of [clear accountability frameworks](#) to regulate and oversee their operations effectively. Alongside these technical challenges, the rise of AI underscores the need for upgrading workforce competencies to keep pace with the rapidly evolving tech-centric financial market.

3.4. Strategic adaptation and capacity building to steer financial supervision through digital transformation

In the evolving landscape of financial supervision, authorities are navigating a transition from existing supervisory technologies to more advanced suptech solutions. This strategic shift is not without its challenges, as the previous sections have delineated, ranging from technical capabilities to governance issues. To effectively bridge the gap between the current state and the aspirational future state of suptech, financial authorities can adopt a series of coherent strategies tailored to their unique organisational contexts.

This section of the Report delves into the prevailing strategic approaches being employed by financial authorities worldwide. It examines the emergence of comprehensive data strategies that incorporate both AI deployment and ethical considerations. It also explores the formulation of explicit suptech strategies, which outline the steps towards adopting and integrating new technologies within supervisory frameworks.

Moreover, the section sheds light on various organisational strategies that underpin digital transformation. These strategies are not monolithic; they are influenced by an array of factors including the authority's structure, leadership vision, technical prowess, and prioritisation of objectives. The strategies serve as a blueprint, guiding authorities through the complexities of digital adoption and ensuring that the transition towards advanced suptech is both methodical and sustainable.

Upon examining the aggregated data, it becomes evident that a mere 13.5% of the survey respondents have adopted

a multifaceted strategic approach, incorporating any combination of data, artificial intelligence, and suptech strategies. Conversely, a significant 36% of the participants appear to be without any such strategies in place.

3.4.1. Data strategies

In the digital age, financial supervision is intrinsically linked to digital processes. A well-articulated, centralised data strategy forms the bedrock of successful suptech strategy development. While suptech solutions can be implemented in an ad-hoc manner, a structured approach to data governance is essential for managing supervisory data effectively.

At the core of effective suptech initiatives is the synergy between robust leadership and a resilient data infrastructure. This synergy enables the orchestration of efficient data flows, from the automated gathering and processing to secure storage, culminating in sophisticated analysis through AI. Each element is crucial in equipping supervisory authorities to adeptly manage the complexities of today's financial systems.

Ultimately, a strategic approach to suptech reinforces the foundation for all supervisory activities. It paves the way for authorities to leverage technology not just for operational efficiency but also for proactive oversight, risk assessment, and policy formulation. By embracing a strategic framework, supervisory authorities can ensure that their digital transformation initiatives are not only effective but also sustainable and forward-looking.

Most authorities have a data strategy either currently operating or in development, led by a Chief Data Officer or a data analytics unit.

78% of respondents have an actively operating data strategy or are developing one. This prevalence of data strategies indicates a shift towards viewing data not merely as an operational necessity but as a strategic asset warranting dedicated leadership, often in the form of a Chief Data Officer, as reported by 26% of these authorities.

The commitment to data as a strategic resource is further underlined by the fact that these strategies are not just ad-hoc efforts but are led by specialised roles within the organisation. Such roles are tasked with overseeing the data life cycle, from its collection to its utilisation for decision-making, and ensuring that data practices align with broader organisational goals and regulatory requirements.

Having a data strategy in place, led by dedicated leadership, enables these authorities to streamline their data management processes, improve the quality and accessibility of data, and ensure its alignment with compliance and governance standards. It reflects an understanding that effective data management is fundamental to the digital transformation journey of supervisory functions, allowing for more informed policy decisions, risk assessments, and supervisory interventions.

Chief Data Officers and their teams are at the helm of this transformative approach, pioneering the use of data to drive innovation, efficiency, and transparency within financial supervisory authorities. They are responsible for laying down the foundation of data governance frameworks, promoting data literacy across the organisation, and spearheading initiatives that harness data analytics, machine learning, and AI to elevate supervisory capabilities.

FIGURE 49.
DOES YOUR AGENCY HAVE AN OVERALL DATA STRATEGY? (N=55)

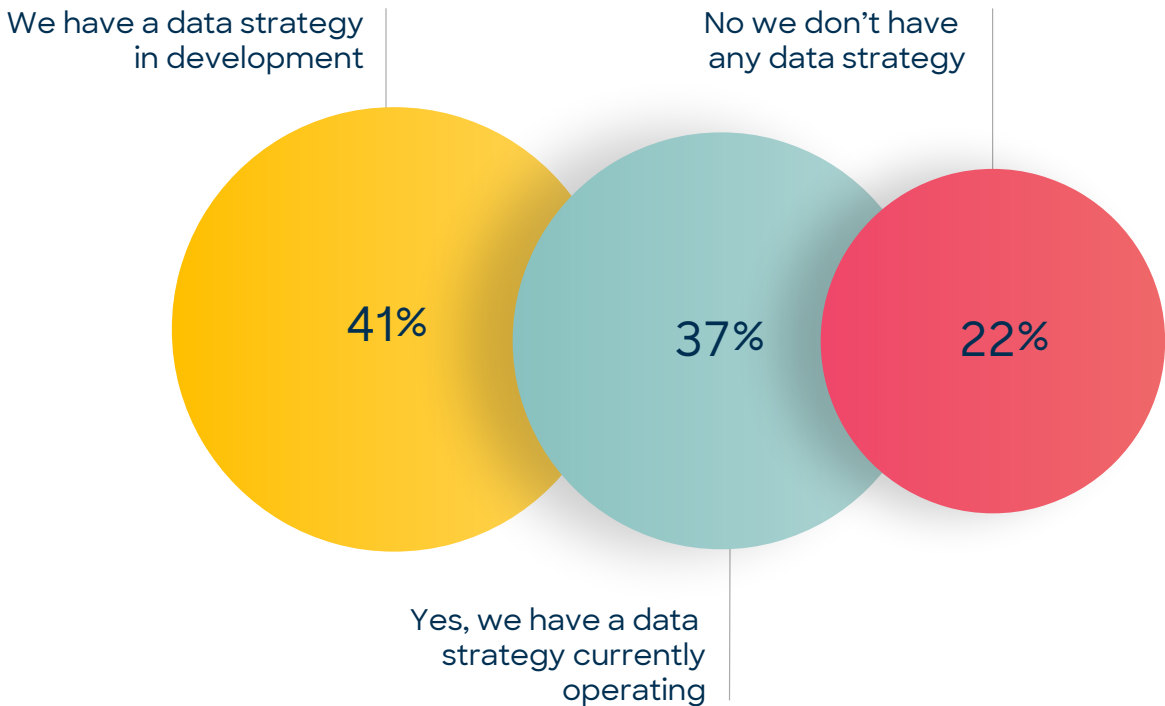
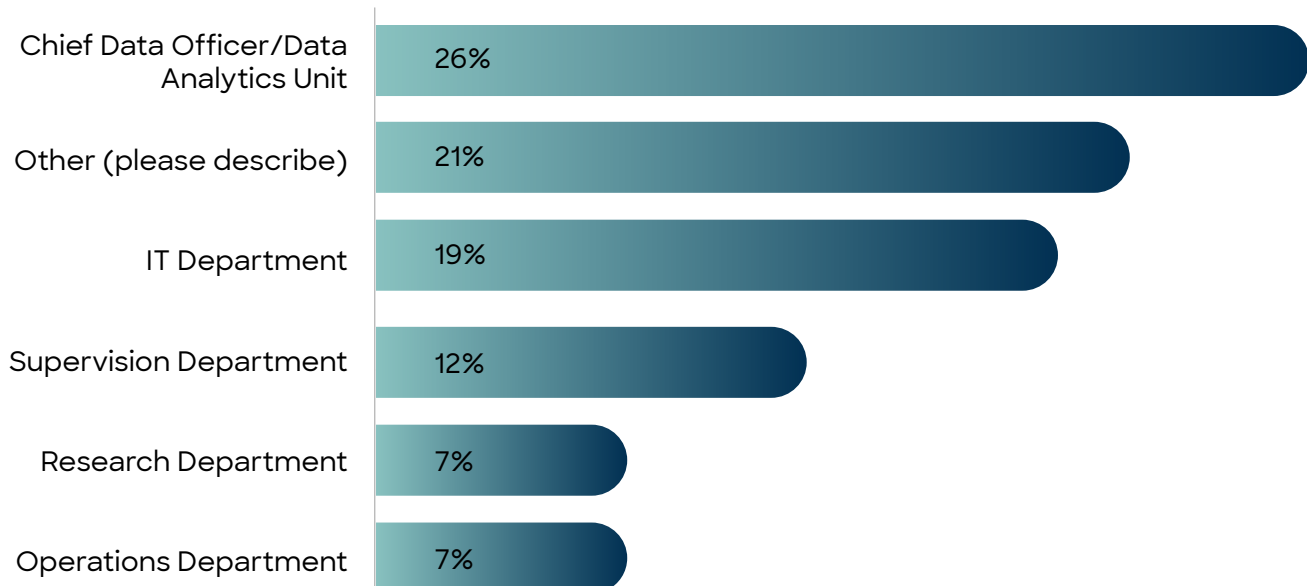


FIGURE 50.

WHO IS LEADING OR WILL LEAD THIS DATA STRATEGY INITIATIVE? (N=42)



Data science capabilities are typically embedded directly into supervisory areas, but centralised data units and coordinated data science teams are increasingly common.

In addition to having sufficient leadership and strategies in place, it is critical for financial authorities to organise their data science capabilities in a manner suitable to best meet their needs.

To this end, 48.2% of the financial authorities report that they strategically organise their data science capabilities primarily through dedicated roles within supervisory areas, recognising the pivotal role that data plays in supervisory functions. Within these organisations, specialised roles such as data scientists and data analysts are established within the supervisory teams to focus on leveraging advanced analytics and data-driven insights. These dedicated professionals collaborate closely with supervisory teams, bringing their expertise to bear on tasks ranging from risk assessment and fraud detection to compliance monitoring.

The Financial Superintendency of Colombia (SFC) is an example of a supervisory authority that organises [their data science capabilities](#) primarily through dedicated roles within supervisory areas, focusing on automated data processing, real-time analysis, and digital supervision.

In contrast to this approach, 35.2% of the financial authorities report that they adopt a centralised approach by establishing a dedicated data science team. This centralised-services model often follows a hub-and-spoke structure, where a core data science team serves as the central hub, collaborating with various supervisory units acting as spokes. The central team in the hub-and-spoke model, equipped with specialised data scientists, analysts, and experts in machine learning, works collaboratively to address overarching challenges.

Similar to this model is the structure of the De Nederlandsche Bank's (Dutch Central Bank - DNB) Data Science Hub. The DNB, committed to becoming more data-driven, [established the Hub](#) within

its Statistics division in 2017. The Hub collaborates with various departments, fostering a community of data scientists, who focus on leveraging advanced data analytics and insights for various tasks. This centralised team focuses on overarching challenges and fosters innovation and consistency in methodologies across different supervisory functions.

This hub-and-spoke model can also be observed in the United Kingdom Financial Conduct Authority’s (FCA) setup, where Data Science Units work [across various segments](#) of the agency, integrating sector expertise for efficient risk analysis and process automation.

By consolidating data science expertise in a central unit, financial authorities aim to

promote consistency in methodologies, share best practices, and foster innovation across different supervisory functions. This centralised model ensures a unified approach to data analysis and allows for efficient resource allocation, as the core team can support multiple supervisory areas with diverse data needs.

While both centralised and distributed models have their merits, the hub-and-spoke approach emphasises the importance of creating a hub of data science excellence to serve and elevate the analytical capabilities of the entire organisation.

FIGURE 51.
HOW ARE YOUR AGENCY’S DATA SCIENCE CAPABILITIES ORGANIZED? (N=54)

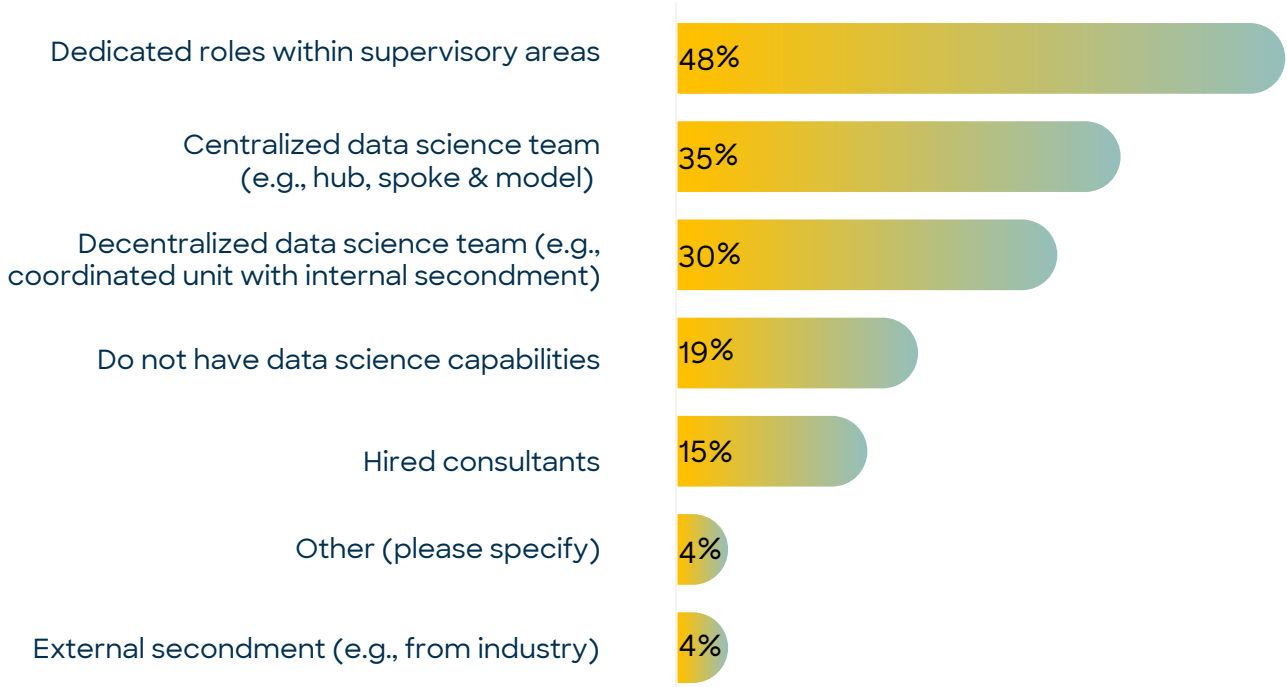
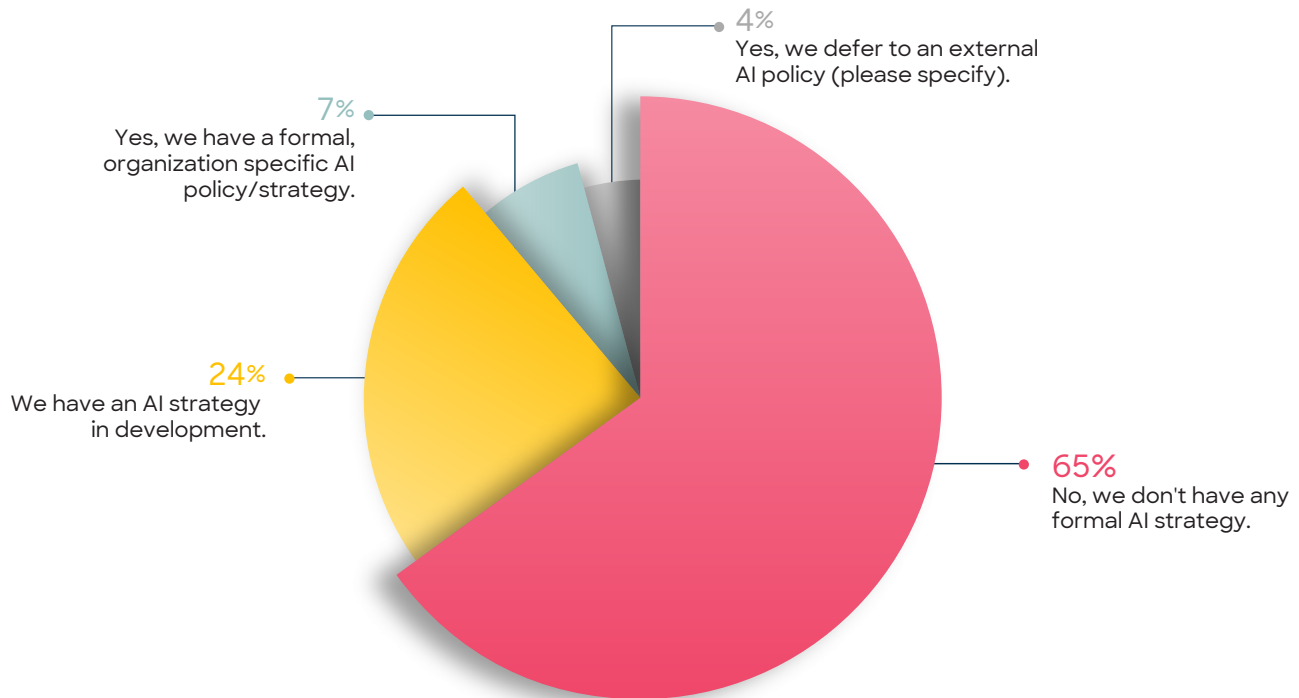


FIGURE 52.

DOES YOUR AGENCY HAVE AN AI POLICY OR STRATEGY? (N=54)



3.4.2. AI strategies

The majority of financial authorities have yet to formalise a comprehensive plan or framework specifically focused on the adoption and use of artificial intelligence (AI) in their operations.

The present landscape of AI strategy among financial authorities indicates a nascent stage of formal adoption. With 65% of respondents indicating the absence of a formal AI strategy, it is clear that a significant portion of the financial authorities is yet to institutionalise AI at a strategic level. Contrastingly, a small fraction of 11.1% report having established an AI policy or adhere to external standards such as the [Government of Canada's AI Policy Guidance](#), showcasing a proactive stance towards AI governance. An additional 24.1% of institutions are in the

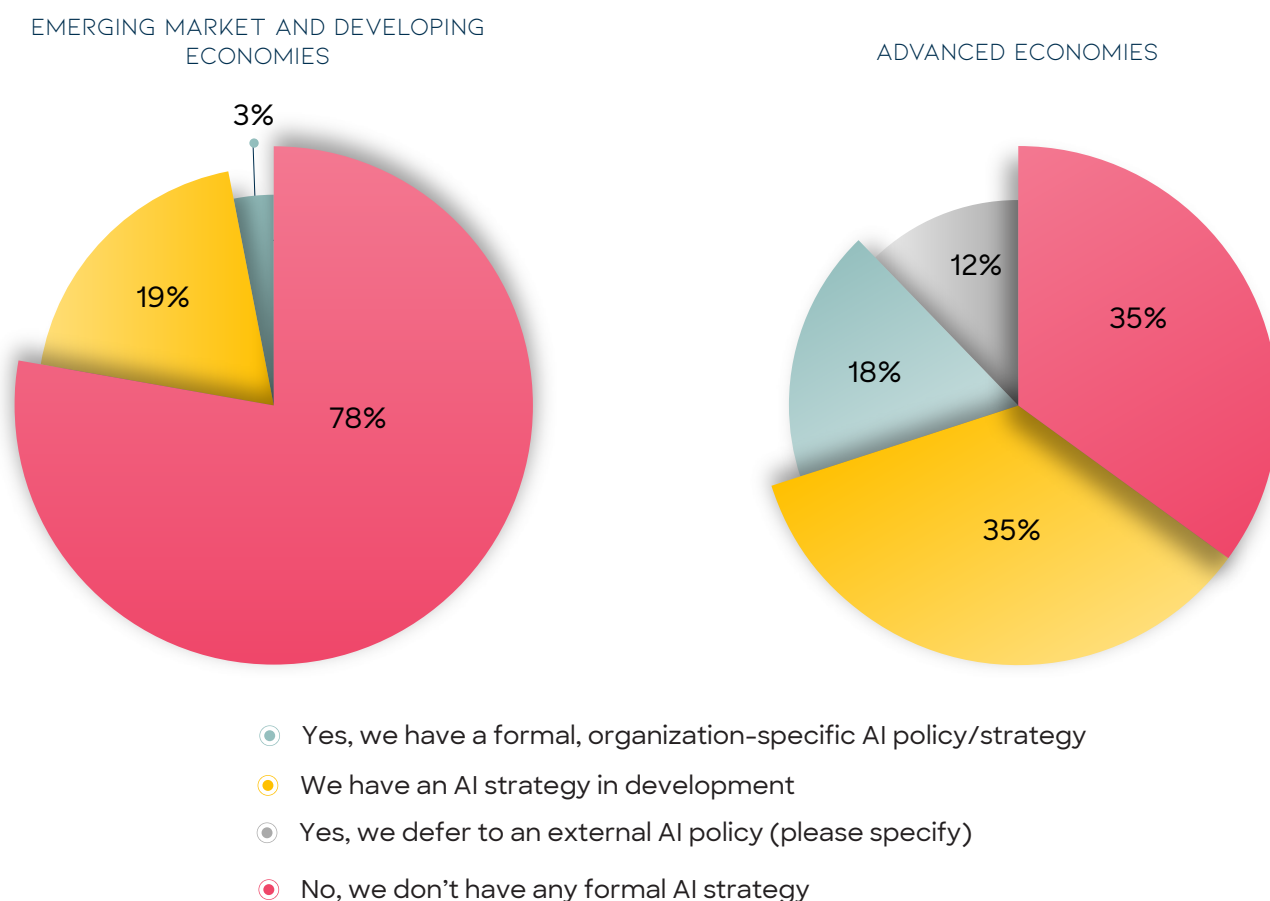
process of formulating their AI strategies, reflecting a growing recognition of AI's potential and the challenges and risks to manage and mitigate.

The lag in the adoption of AI strategies could be attributed to the foundational need for a robust data strategy, which ensures the availability of high-quality data – a prerequisite for effective AI deployment. This connection suggests that the development of AI capabilities is likely to accelerate as organisations solidify their data management frameworks. As AI continues to become an integral part of 4G supervisory technologies, it becomes increasingly important for financial authorities to proactively develop comprehensive AI strategies. These [strategies](#) should not only address the technical aspects of AI implementation but also consider ethical, legal, and operational dimensions to harness the full potential of AI in financial supervision.

FIGURE 53.

DOES YOUR AGENCY HAVE AN AI POLICY OR STRATEGY? (N=54)

SEGMENTED BY ECONOMY



In response to this emerging need, financial authorities might consider engaging in cross-sector collaborations to share best practices and develop common frameworks, particularly for data governance that underpins AI applications. Additionally, investment in training programs and partnerships with technology providers could bridge knowledge gaps and accelerate the development of AI competencies within regulatory bodies.

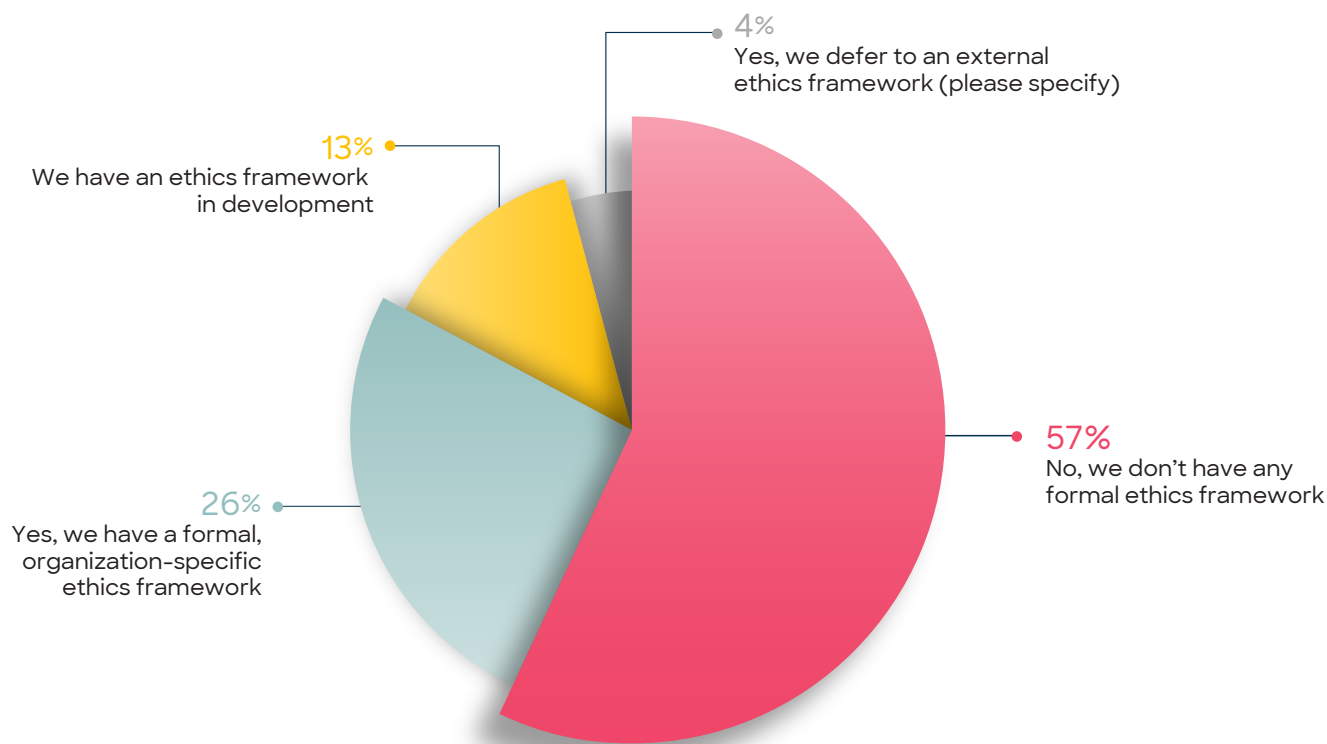
Breaking down by respondents by economic status reveals a massive discrepancy. The vast majority (78%) of

financial authorities from EMDEs report having no formal AI strategy at all, versus only a minority (35%) from AEs.

As the field of AI continues to evolve, all financial authorities may increasingly recognise the need to articulate clear strategies to harness the potential benefits of AI while managing associated risks. However, those in EMDEs may require support in developing such AI policies when they are initially focused on other prerequisites like data strategy and associated suptech for ensuring tidy supervisory data via automated data collection and processing.

FIGURE 54.

**DOES YOUR AGENCY HAVE AN ETHICS FRAMEWORK AROUND YOUR DATA AND/OR AI?
(N=54)**



Addressing the gap in data and AI ethics is becoming increasingly crucial for financial authorities as only 30% have implemented some form of a data/AI ethics framework.

Most respondents (57.4%) have yet to establish an ethics framework addressing the use of data and AI technologies. The existing 30% that have implemented some form of an ethics framework, either have directly established frameworks (25.9%) or align with external ethics frameworks (3.7%). 13% of the agencies are in the process of developing them, contributing to a collective 42.6% within the sector actively engaging with the ethical implications of their technological strategies. This points to a growing awareness of the need for responsible oversight as these powerful tools become more integral to financial supervision.

3.4.3. Suptech strategies

91% of respondents report lacking a formal, comprehensive, explicit suptech strategy. While this is apparently mitigated by the abundance of data strategies, respondents report resulting challenges for the operationalisation of suptech solutions.

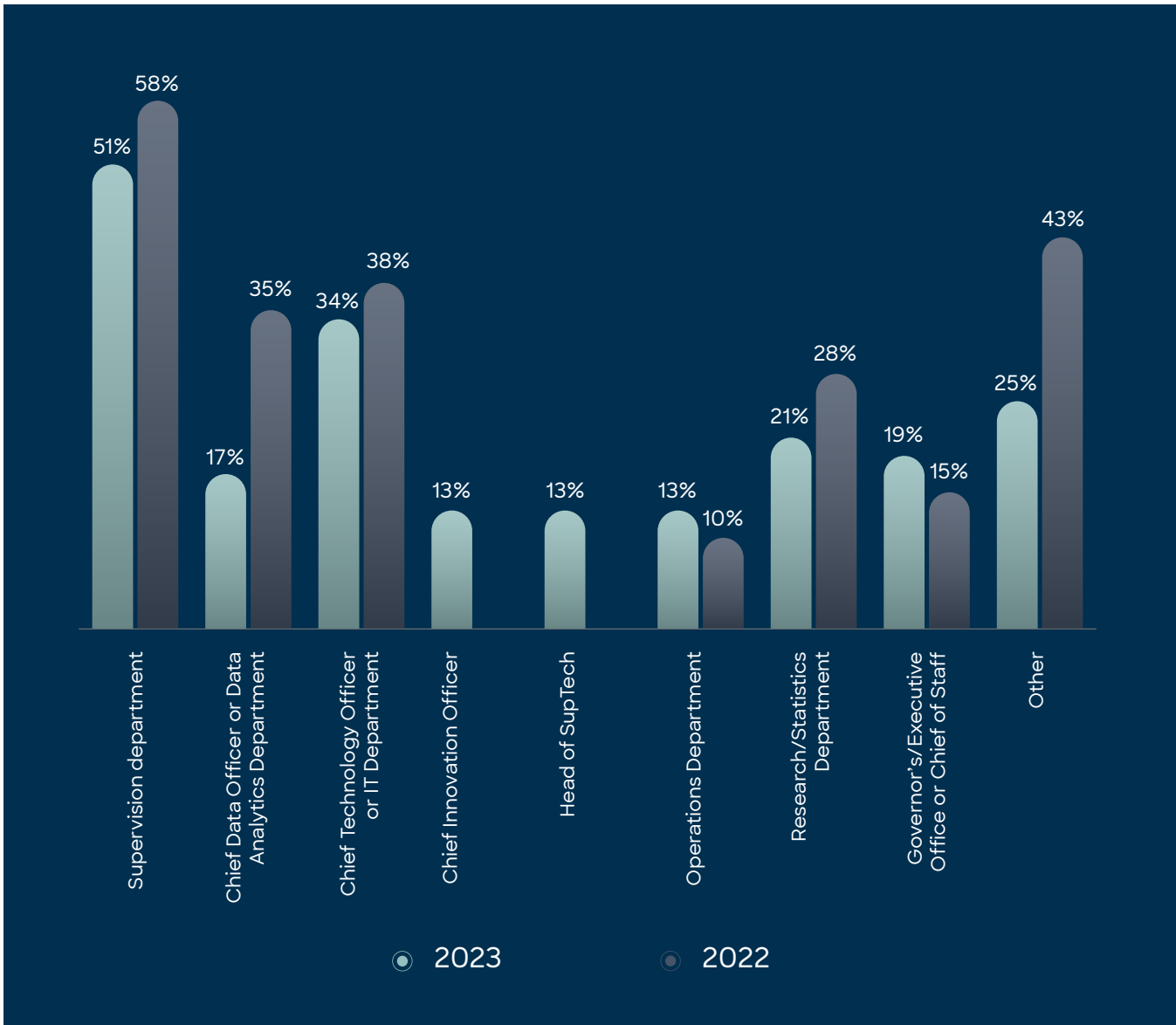
Despite the widespread adoption of suptech by 81% of financial authorities and the development of data and AI strategies, only a small fraction, 9%, possess an explicit suptech strategy, as detailed in section 3.1 of this report. This gap highlights a trend where suptech tools are often deployed experimentally or developed incrementally without a unifying strategic blueprint.

The absence of a formal suptech framework implies these institutions may lack a structured approach to harness the full potential of suptech, potentially missing out on strategic alignment and long-term planning. This is corroborated by findings in section 3.6, where 25.5% of authorities recognise the absence of a formal suptech roadmap as a significant barrier to progress, emphasising the need for a strategic, forward-looking stance in the adoption and integration of supervisory technologies.

Suptech strategies often emerge as a result of evolving complementary strategies and the practical experience gained from developing suptech applications, rather than being established from the outset.

Only 17% of authorities with a suptech strategy or roadmap had the foresight to establish it prior to the development of any suptech applications.

FIGURE 55.
WHO IS LEADING OR WILL LEAD YOUR SUPTECH INITIATIVES?
2022 VS 2023



Meanwhile, a significant 39% drew from their hands-on experience with suptech application development to shape their strategy. The remaining 44% took a broader approach, crafting a generalised suptech strategy as a segment of wider digital transformation or data strategies.

This trend signals that the development of suptech strategies is often an intentional and comprehensive organisational effort, typically situated within the grander scheme of digital transformation agendas or as a crucial segment of a comprehensive data strategy. By incorporating suptech strategies into these overarching plans, financial authorities exhibit a strategic and progressive stance on employing technology to augment supervisory effectiveness.

The intentional crafting of suptech strategies, whether as a core element of broader digital initiatives or as a standalone strategic focus within an all-encompassing data strategy, reveals a sophisticated understanding of the unique challenges and opportunities at the convergence of financial regulation and tech innovation. Such strategic foresight positions these authorities to proficiently maneuver through the complexities of the digital age, harnessing a bespoke, tech-forward approach to refine supervisory activities.

While dedicated roles like Head of Suptech have become less uncommon, leadership of suptech initiatives continues to reside primarily within supervision and IT departments.

The growing implementation of suptech solutions escalates the need for specialised suptech competencies, prompting financial authorities to invest in dedicated roles and departments that spearhead the management and strategic direction of digital transformation efforts. A comparative overview of the

responsibilities for leading suptech initiatives within financial authorities for the years 2022 and 2023 illustrates a shift in leadership roles and departmental responsibilities over these two years.

In 2023, the supervision department remains the primary leader of suptech initiatives, with a slight decrease from 58% in 2022 to 51%. The role of the Chief Data Officer or data analytics department has seen a marked increase from 17% in 2022 to 35% in 2023, highlighting the growing importance of data management in suptech. Leadership by the Chief Technology Officer or IT department has remained relatively stable, decreasing slightly from 38% in 2022 to 34% in 2023.

A new role, Head of Suptech, has emerged in 2023, indicating that 13% of the organisations have established a dedicated position to oversee suptech efforts, underscoring the increasing specialisation and focus on suptech within financial authorities. The Chief Innovation Officer is another role being created by the authorities and tasked with leading suptech innovation (13%). Lastly, the 'Other' category - which mostly indicates hybrid leadership - shows a significant decrease from 43% in 2022 to 25% in 2023.

Notably, the respondent pool for this question has expanded in 2023 compared to 2022 (even though last year the survey sample size was larger), possibly suggesting an overall trend towards the increasing formalisation and diversification of roles responsible for suptech, which aligns with the growing complexity and strategic importance of these initiatives within the financial sector. It reflects a broader understanding that suptech is an integral part of the digital transformation of financial supervision, requiring dedicated leadership and specialised roles.

FIGURE 56.

HAS THE AGENCY CREATED NEW POSITIONS TO LEAD TO DIGITAL TRANSFORMATION AND SUPTECH? (N=64)

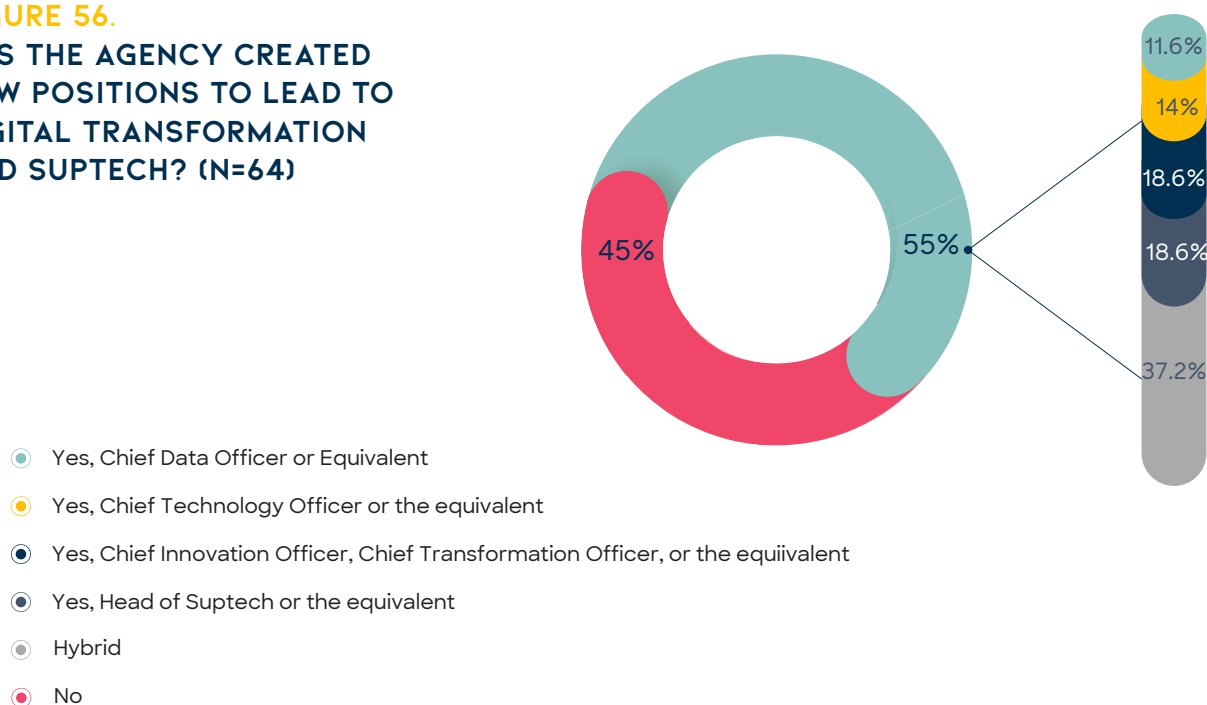
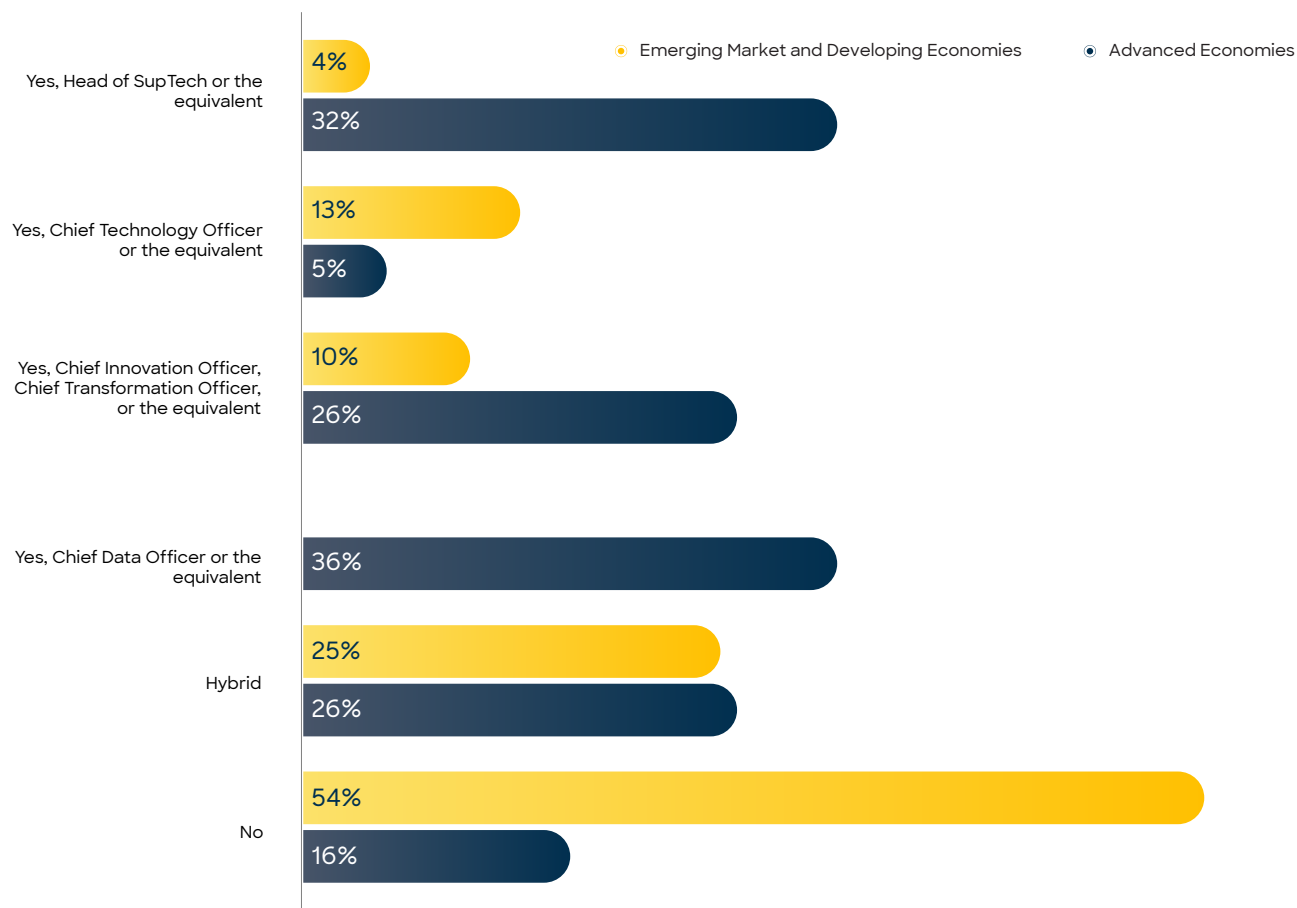


FIGURE 57.

HAS THE AGENCY CREATED NEW POSITIONS TO LEAD TO DIGITAL TRANSFORMATION AND SUPTECH? SEGMENTED BY ECONOMIC STATUS



Predominantly advanced economies (AEs) are establishing new, dedicated roles to guide digital transformation and suptech initiatives. In contrast, emerging markets and developing economies (EMDEs) show a different approach; most authorities there haven't introduced specialised positions for suptech leadership.

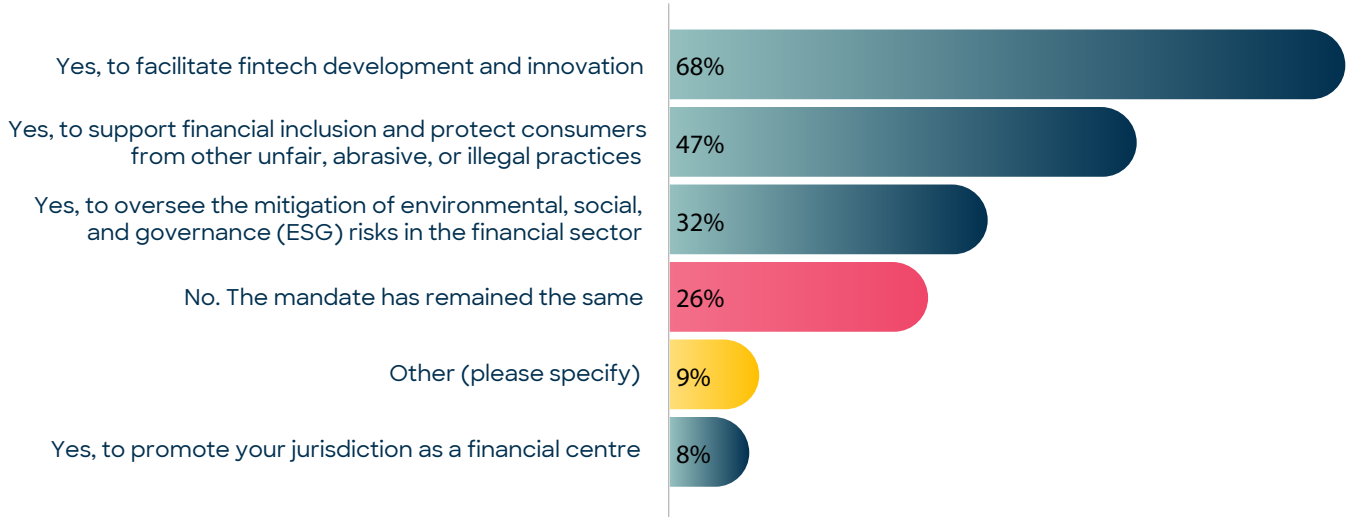
Financial authorities also identified new roles developed specifically to lead digital transformation and suptech. Over half of the respondents (54.7%) have established new roles such as Chief Innovation Officer (CIO) and Head of Suptech, each accounting for 18.6% of the new positions. This move toward creating specialised roles underscores a strategic shift in the governance of suptech. A significant number of respondents (37.2%) are taking a hybrid approach, designating various roles with specific aspects of the digital shift, signifying a trend towards a more integrated and comprehensive organisational change.

This holistic strategy acknowledges that the effective implementation of suptech transcends technology, requiring adept leadership to manage the transition. Our analysis further suggests that the emergence of these focused roles may have contributed to diminishing managerial resistance, which was previously identified as an obstacle to the uptake of suptech.

Survey results indicate a trend where predominantly AEs are establishing new, dedicated roles to guide digital transformation and suptech initiatives. In contrast, EMDEs show a different approach; most authorities there haven't introduced specialised positions for suptech leadership. Those who have, tend to assign these responsibilities to existing roles or create hybrid positions, often integrating suptech responsibilities into the duties of roles like Chief Technology Officer (CTO).

3.4.4. The evolving mandate of financial authorities

FIGURE 58.
HAS THE AGENCY'S MANDATE CHANGED OR BROADENED OVER THE LAST FIVE (5) YEARS? (N=53)



Adapting to the evolving market dynamics, a significant majority of financial authorities have revised their mandates to reflect current trends and challenges.

As the financial sector continues to evolve, financial authorities are recalibrating their mandates to better align with the changing market conditions. A significant 67.9% of these authorities have acknowledged the transformative impact of fintech, prompting them to expand their roles strategically to support and encourage fintech innovation. This forward-thinking approach is aimed not just at fostering a more robust and competitive financial environment, but also at extending financial services to underserved markets, thus enhancing financial inclusion.

In addition, 47% of financial authorities have broadened their mandates to include stronger consumer protection measures. This shift underscores a growing commitment to protecting consumers from unfair or illicit practices, an increasingly vital consideration in an era marked by rapid technological advancements.

The emerging focus on ESG issues is another critical area of adaptation. With 32% of financial authorities now incorporating ESG risk mitigation into their oversight responsibilities, there is a clear recognition of the importance of aligning financial activities with sustainability goals. For example, the Banco Central Do Brasil (BCB) recently released a [“Report on Social, Environmental and Climate-related Risks and Opportunities”](#) which outlines such responsibilities. Even more recently, the European Central Bank (ECB) has defined as the second of their three supervisory priorities for 2024-2026 a need to “accelerate the effective remediation of shortcomings in governance and the management of climate-related and environmental risks.”

3.4.5. Developing capabilities to digitally transform

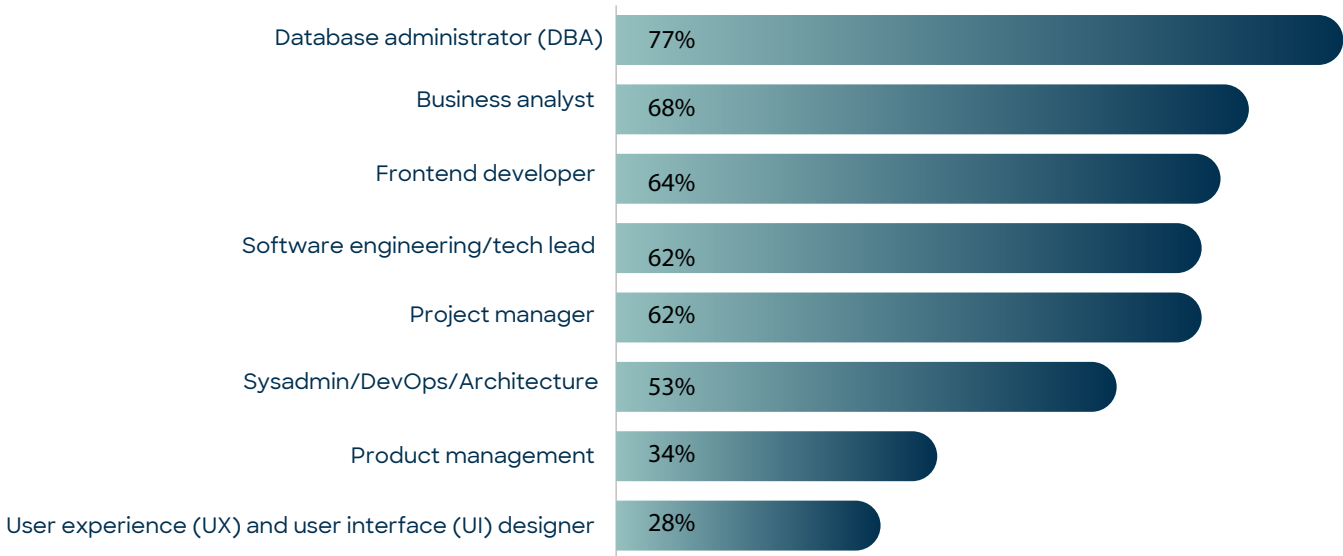
At this pivotal moment in financial supervision, authorities are encountering a dynamic shift driven by technological advancements, calling for strategic adaptation and informed decision-making. Recognising the essential role of adequate resources and expert knowledge, financial authorities understand these as key to harnessing the full potential of suptech solutions. As the financial sector undergoes continual transformation through technology, the proactive application of suptech becomes a strategic imperative, a critical step towards fostering a regulatory environment that is resilient, responsive, and anticipates future trends.

To enhance their suptech capabilities, a majority of financial authorities are turning to knowledge exchange platforms and collaborative forums. These avenues are invaluable for sharing insights and best practices, and for keeping up with the rapid pace of technological advancements in suptech. They enable quick sharing of information and help build a collective intelligence that is essential for effective supervision in today’s digital era.

Moreover, there is a clear focus on skills development. Designing and implementing suptech requires a mix of technical and soft skills. This includes a strong foundation in digital technologies and data, particularly in areas like AI and ML that is beneficial for developing tools that can efficiently process and analyse this data. Skills in big data analytics and the ability to draw meaningful insights from complex datasets are vital. In addition to these technical and data skills, project management and strategy development capabilities are necessary to effectively implement suptech strategies and projects. Finally, innovation, problem-solving, communication, and collaboration and human centred design

FIGURE 59.

WHICH OF THE FOLLOWING SKILLS ARE AVAILABLE WITHIN THE AGENCY TO SUPPORT SUPTECH? (N=53)



skills are essential for navigating the evolving landscape of suptech ensuring effective development and implementation of solutions that meet the needs of various stakeholders. Many agencies recognise the necessity of ongoing training to keep up with technological advancements. By investing in skills development, they ensure their teams are capable of effectively managing and leveraging emerging technologies, thus reinforcing the strength and adaptability of their supervisory frameworks in a tech-driven financial world.

Survey results reflect a uniformity in the needs expressed by financial authorities, mirroring the challenges and opportunities that pervade the suptech domain. These findings highlight training, funding, and technical assistance as key areas where financial authorities are seeking support. By addressing these needs, authorities can better navigate and capitalise on the evolving landscape of suptech, ensuring their readiness to meet both current and

future supervisory challenges.

Financial authorities, in their pursuit of enhancing suptech, have cultivated a diverse set of skills within their workforce, including those associated with digital transformation like product management and UI/UX design.

Designing and implementing suptech solutions demands a blend of both technical and soft skills. Foundational knowledge in digital technologies and data, particularly in areas like Artificial Intelligence (AI) and Machine Learning (ML), is crucial for developing tools capable of efficiently processing and analysing large data sets. Additionally, proficiency in big data analytics is essential for extracting meaningful insights from complex data.

Alongside these technical skills, capabilities in project management and strategy development are fundamental to the effective execution of suptech

strategies and projects. These skills ensure that suptech initiatives align with the broader objectives of the financial authorities and are implemented efficiently.

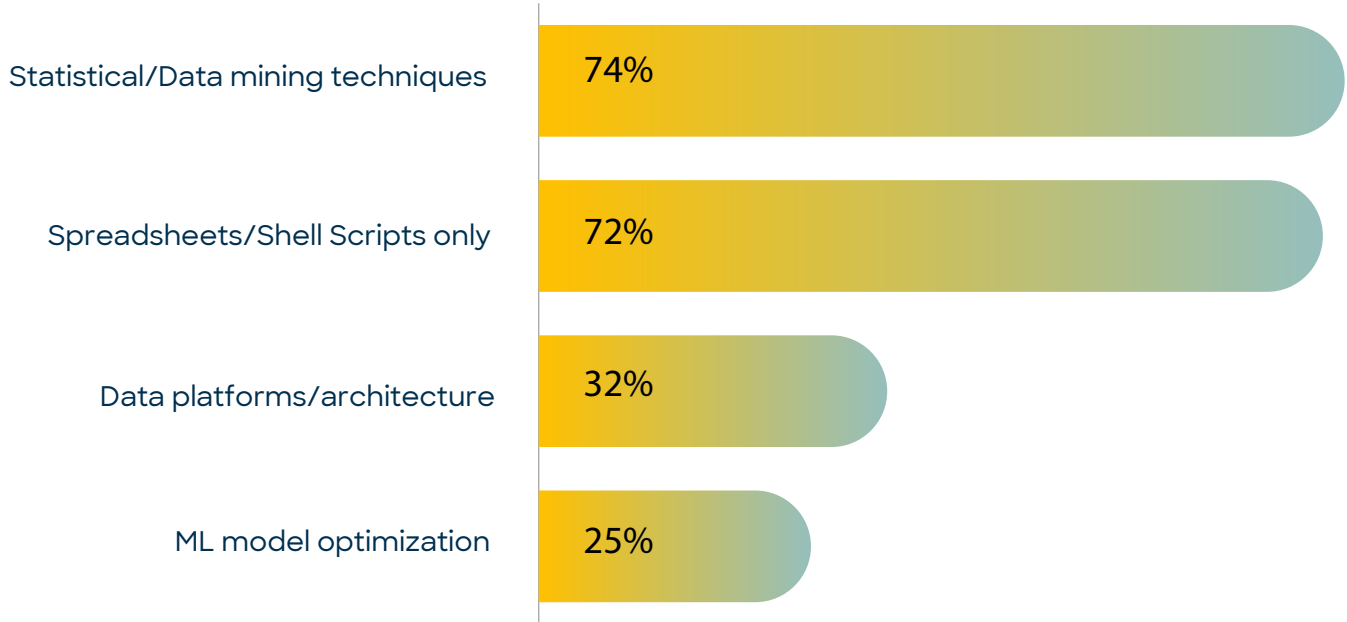
Moreover, soft skills such as innovation, problem-solving, effective communication, and collaboration, coupled with a focus on human-centered design, are vital for navigating the evolving suptech landscape. These skills are essential for developing and implementing solutions that effectively meet the needs of various stakeholders.

A survey of financial authorities reflects this skill set mix: 77.4% report having Database Administrators (DBAs), 67.9% employ business analysts, and 64.2% have roles like frontend developers, software engineers, and project managers. This diverse skills composition represents a comprehensive approach, integrating technical prowess with a deep understanding of supervisory functions and project management to effectively incorporate suptech into the operational fabric of financial authorities.

There are also indications of a successful digital transformation and a focus on supervisor-centered design in suptech solutions, as evidenced by the relatively significant presence of product management (34%) and UI/UX design (28.3%) roles within these organisations. This suggests an increasing emphasis on creating user-friendly and effective suptech tools, underlining the commitment to enhancing the supervisory landscape with well-designed, innovative technologies.

A review of the breakdown by economic status highlights some disparities. Financial authorities in AEs tend to focus more than their EMDE counterparts on software engineering and tech leads (82% vs 53%), sysadmin and devops roles (76% vs 42%) and product management (53% vs 25%). Conversely authorities in EMDEs focus on frontend development (69% vs 53%). This indicates a focus in EMDEs on user interfaces such as reports and dashboards, in contrast to the focus in AEs on productisation of suptech systems.

FIGURE 60.
WHAT ARE THE SKILL LEVELS OF THE DATA SCIENTISTS AND ANALYSTS? (N=53)



Reflecting the current stage of suptech adoption as outlined in the SupTech Generations framework, the distribution of skillsets within financial authorities aligns with the maturity level of their suptech applications. The expertise predominantly caters to the requirements of first and second-generation (1G/2G) suptech tools rather than the more advanced third and fourth-generation (3G/4G) technologies.

The skillset composition within financial authorities reveals a focus on foundational data management techniques, with a majority of data analysts and data scientists (73.6%) proficient in data mining and statistical methods. These skills are typically associated with manual approaches to data collection, processing, and analysis. Furthermore, a significant portion (71.7%) of these professionals demonstrate adeptness in using spreadsheets and shell scripts. This proficiency indicates the capacity to conduct basic data munging and transformations, crucial for deriving metrics. However, it also suggests a reliance on manual processing and storage methods, as well as code analysis.

Yet, there are emerging indications of a shift towards more sophisticated, automated data handling. About 32.1% of respondents have reported expertise in data platforms and architectures specifically designed for working with Big Data. This expertise is essential for managing and analysing vast datasets more efficiently and effectively, marking a move towards more advanced data management capabilities. Additionally, 24.5% of respondents have indicated skills in machine learning modelling.

This skillset alignment suggests that most financial authorities are equipped with

capabilities more suited to descriptive and diagnostic analytics, characteristic of the 1G/2G suptech phase. These foundational skills are essential for the current stage of suptech development, which primarily focuses on collecting and analysing data in straightforward, often manual ways.

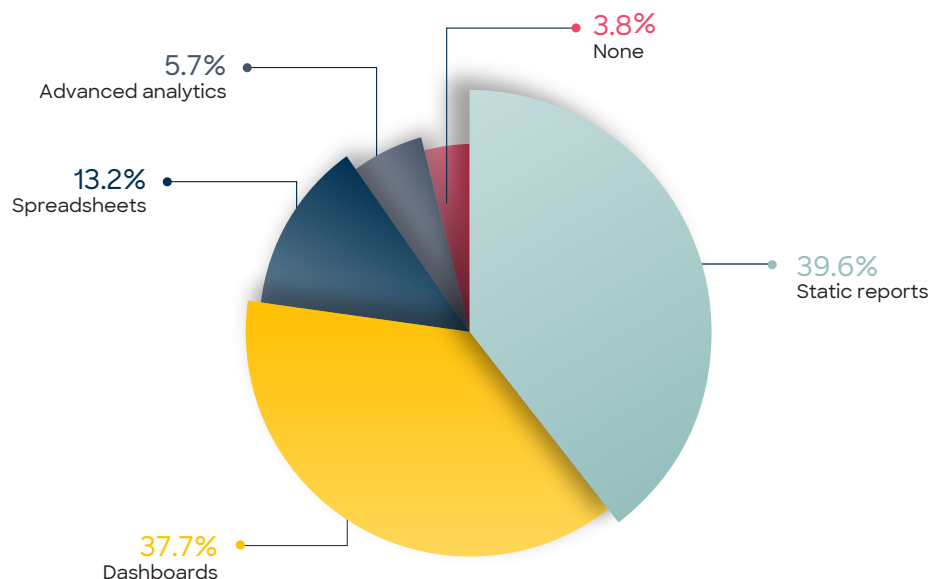
However, as suptech evolves towards more sophisticated 3G/4G applications, which involve predictive analytics, machine learning, and AI-driven solutions, there is a clear need for financial authorities to develop and acquire skillsets that align with these advanced technologies. This shift will necessitate a focus on building competencies in areas like advanced data science, AI and machine learning.

The current distribution of skills, while adequate for present needs, highlights the importance of continuous learning and adaptation as the landscape of financial supervision technology advances. To keep pace with these advancements and fully leverage the potential of higher-generation suptech tools, financial authorities will need to invest in upskilling and reskilling initiatives, fostering a workforce that is adept at navigating the complexities of an increasingly digital and data-driven financial world.

A review of the breakdown by economic status again highlights disparities. Financial authorities in AEs tend to focus more than their EMDE counterparts on mining techniques (82% vs 69%) and ML model optimisation (53% vs 11%). Conversely authorities in EMDEs focus on spreadsheets and shell scripts only (81% vs 53%). This indicates a focus in EMDEs on processing and basic descriptive analytics, in contrast to the focus in AEs on more advanced data science.

FIGURE 61.

WHAT IS THE MANAGEMENT TEAM'S OR BOARD LEVEL OF UNDERSTANDING AND SET OF CAPABILITIES WHEN IT COMES TO DATA? (N=53)



A significant portion of board-level and management teams in financial authorities demonstrate a limited understanding of advanced analytics. This situation highlights a substantial need for targeted capacity building at the highest levels of these organisations.

Executive teams and boards' comfort zone is predominantly with basic tools like static reports (40%) and dashboards (38%). This reliance on simpler forms of data presentation, while useful, indicates a notable gap in their proficiency with more sophisticated data analytics tools.

The current scenario presents a significant opportunity to elevate their understanding and skills. By introducing executive training programs focused on advanced analytics and facilitating peer-to-peer sharing of best practices – especially drawing on the experiences of the 6% who are proficient in using advanced analytics – executive teams can be better equipped.

Enhancing their analytical capabilities would enable these leaders to delve deeper into data, glean more nuanced insights, and make decisions that are more aligned with the complexities of the current financial landscape. Such an upskilling initiative is not just about technical knowledge; it's about broadening the strategic vision of leadership in financial authorities to fully harness the potential of data-driven strategies.

An analysis of the economic statuses of the authorities' jurisdictions indicates that while management teams in both AEs and EMDEs focus primarily on static reports and dashboards, there are major discrepancies at the extremes. It was exclusively authorities in EMDEs that reported management teams with only spreadsheet capabilities (19%) or no data capabilities at all (6%). Meanwhile it was exclusively authorities in AEs that reported management teams with advanced analytical skills (18%). This underscores the needs reported elsewhere in this report for trainings and capacity building not only for supervisors, but of the executive and management teams as well.

Training and technical assistance are the topmost areas of support sought by financial authorities, with technological and data science training programmes leading the pack. The demand for direct support in the design and development

of suptech solutions, specifically through funding assistance and the provision of free digital public goods, is also strong. Financial authorities in EMDEs outpace their peers in AEs in demand for virtually every area of support.

FIGURE 62.
WHICH OF THE FOLLOWING AREAS OF SUPPORT IS YOUR AGENCY SEEKING? (N=52)

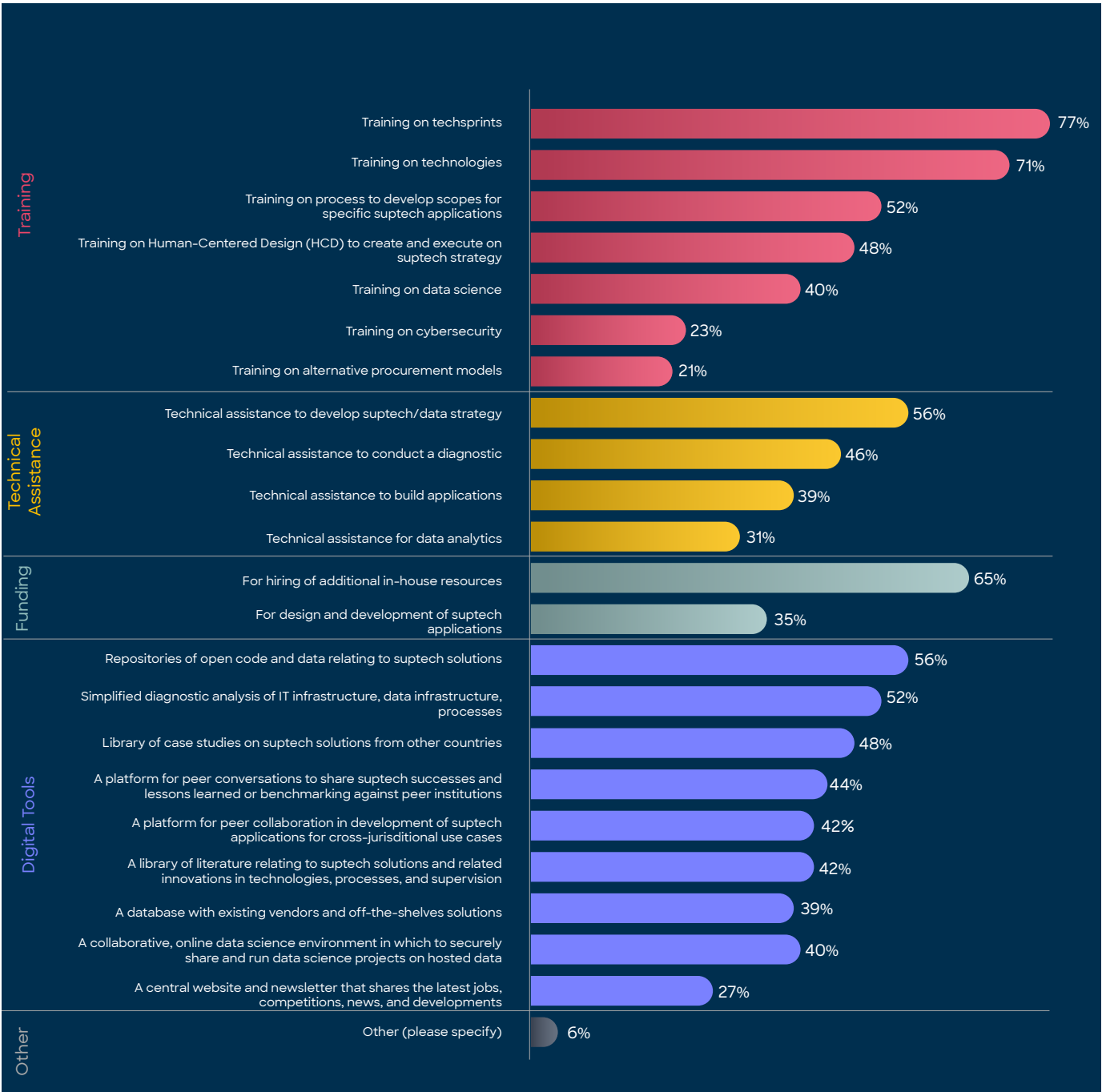
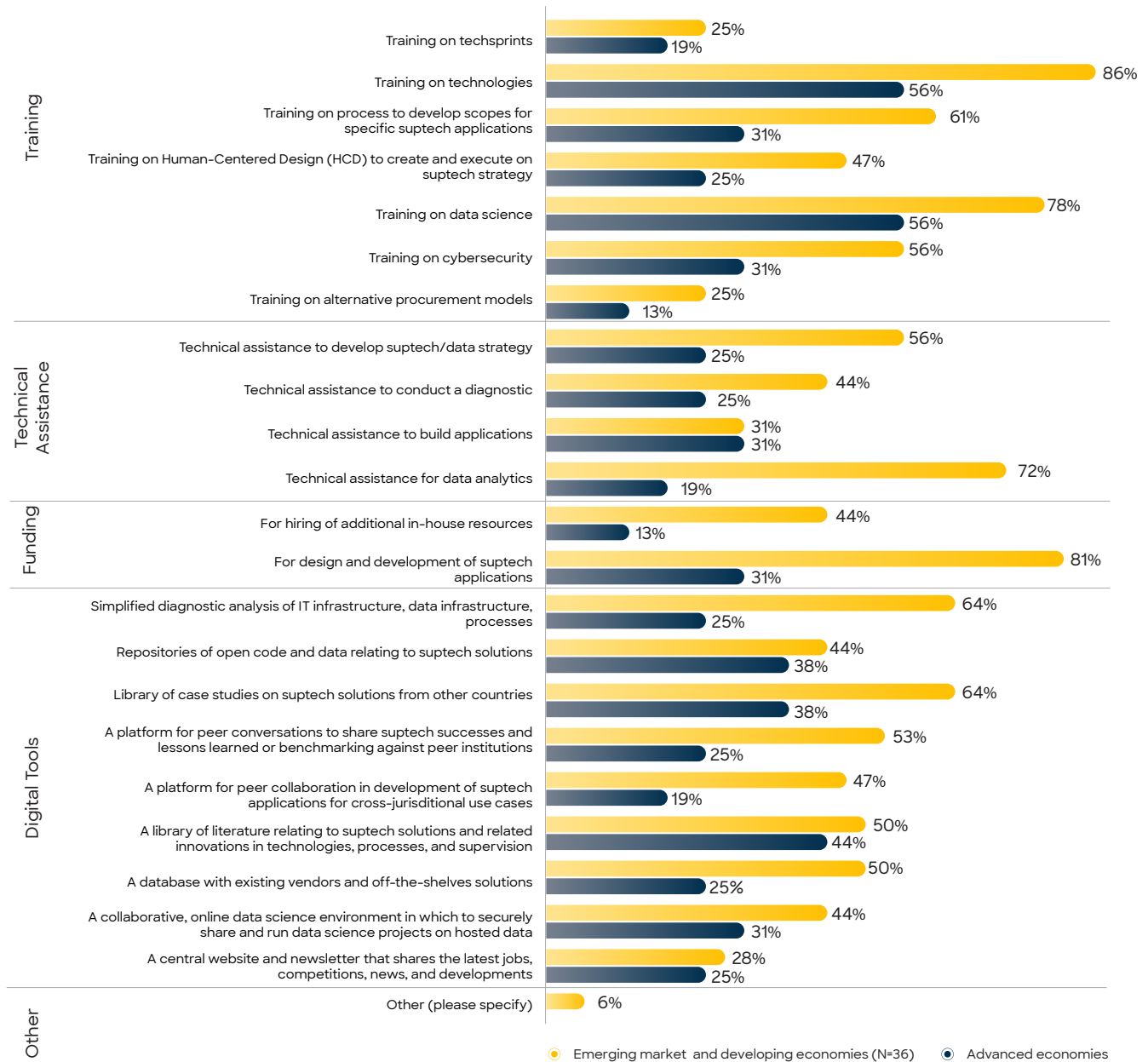


FIGURE 63.

WHICH OF THE FOLLOWING AREAS OF SUPPORT IS YOUR AGENCY SEEKING? (N=52)
SEGMENTED BY ECONOMIC STATUS



A substantial 76.9% of financial authorities underscore the criticality of technology training, reflecting an awareness that staying abreast of tech advancements is crucial for the effective utilisation of suptech tools. Complementing this, 71.2% stress the need for data science training, highlighting the increasing relevance of data analytics capabilities in financial supervision.

In addition, 55.8% of respondents identify a pressing requirement for technical assistance in data analytics, which speaks to the complexities involved in deriving meaningful insights from extensive financial data sets. This reflects a broader understanding that proficiency in data analytics is fundamental to successful suptech deployment.

The slight decrease in these percentages from last year can be attributed to the various strategies that financial authorities have already implemented. These include extensive IT and data analytics training, human-centred design (HCD) methodologies, and active engagement in knowledge-sharing forums. The Lab's [Capacity Building & Education](#) programmes have been pivotal in addressing these needs, providing experiential training focused on the impact of fintech and digital assets on financial supervision, on the application of best practices in data science cutting-edge tools for data-driven supervision, and on techniques for data-informed and user-centred solutions design, change management, and products and organisational innovation.

Moreover, 65.4% of authorities are actively seeking funding support for designing and developing suptech tools, highlighting the significant initial investment required to fully leverage technological innovations in supervisory practices. This demand for funding reflects the considerable returns anticipated from these investments.

There is also a substantial ongoing demand for digital public goods and other knowledge-sharing resources. These tools are vital for disseminating experiences across the industry and aid in the informed development and prioritisation of suptech solutions.

Importantly, financial authorities in EMDEs are more likely than their counterparts in AEs to seek support across almost every identified area, indicating a keener demand for assistance in adapting to the evolving landscape.

3.5. Suptech solutions life cycle

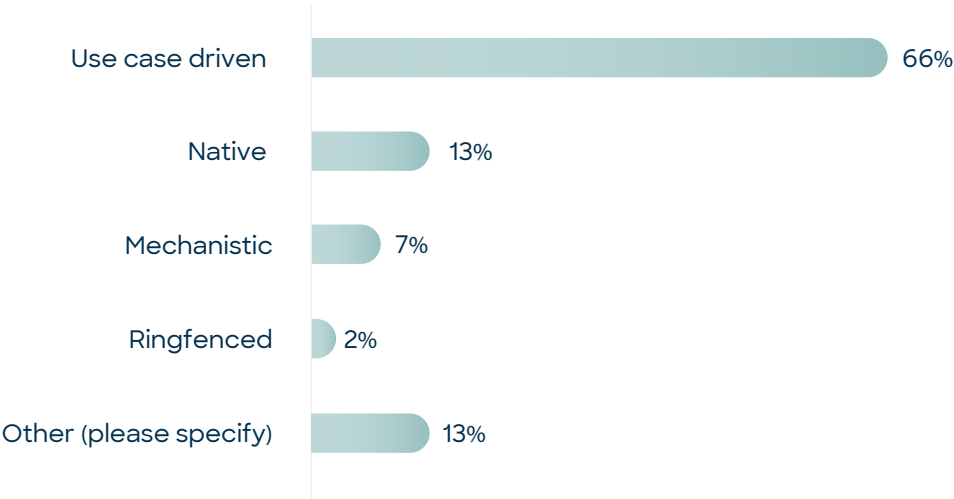
Most financial authorities employ suptech to address a specific supervisory use case in an end-to-end fashion. Smaller portions of authorities invest either in more ambitious and costly suptech-native infrastructure or incremental upgrades to specific technologies.

A significant majority of financial authorities (65.6%) are adopting a “use case-driven approach” in their suptech initiatives. This methodology stands out for its agile, iterative process, targeting comprehensive solutions for specific, supervisor-centric use cases. Instead of the “mechanistic” approach, which focuses on updating single layers of technology (like replacing one dashboard with another), this strategy involves addressing the entire supervisory stack for a given use case, from data collection to final data products. Such an approach enables authorities to implement solutions focused on specific needs, quickly evaluate their impact, and make swift adjustments as required.

Prominent examples of financial authorities employing this approach include Bangko Sentral ng Pilipinas (BSP), the Securities and Exchange Commission (SEC) of the Philippines, Peru's Superintendencia de Banca, Seguros y AFP (SBS), Indonesia's Otoritas Jasa Keuangan (Financial Services Authority) (OJK), the Bank of Ghana (BOG), and the Reserve Bank of India (RBI) under the Lab's [Launchpad](#) program. These institutions have effectively identified priority areas and developed roadmaps through diagnostic processes, integrating both legacy systems and new infrastructures in their suptech strategies.

FIGURE 64.

WHICH OF THE FOLLOWING OPTIONS BEST DESCRIBES YOUR AGENCY’S APPROACH TO SUPTECH? (N=61)



Beyond the prevalent “use-case driven” approach, a small portion of financial authorities explore alternative methodologies. Notably, 13% are pursuing the “native” approach, which involves significant investment in developing suptech-native infrastructure from scratch. High-profile examples of this approach include the European Central Bank (ECB)’s ambitious four-year, €210 million [project](#) to create comprehensive suptech solutions and training programs across various supervisory areas, and the National Bank of Rwanda’s three-year, \$1 million Electronic Data Warehouse (EDW) [project](#) aimed at establishing a centralised data repository with integrated data pipelines and analytics tools. These projects, often involving collaborations with major management consulting firms, carry substantial risks but promise considerable rewards. They typically have long timelines and are executed by well-established players who have significantly influenced the existing legacy infrastructure and traditional suptech methodologies.

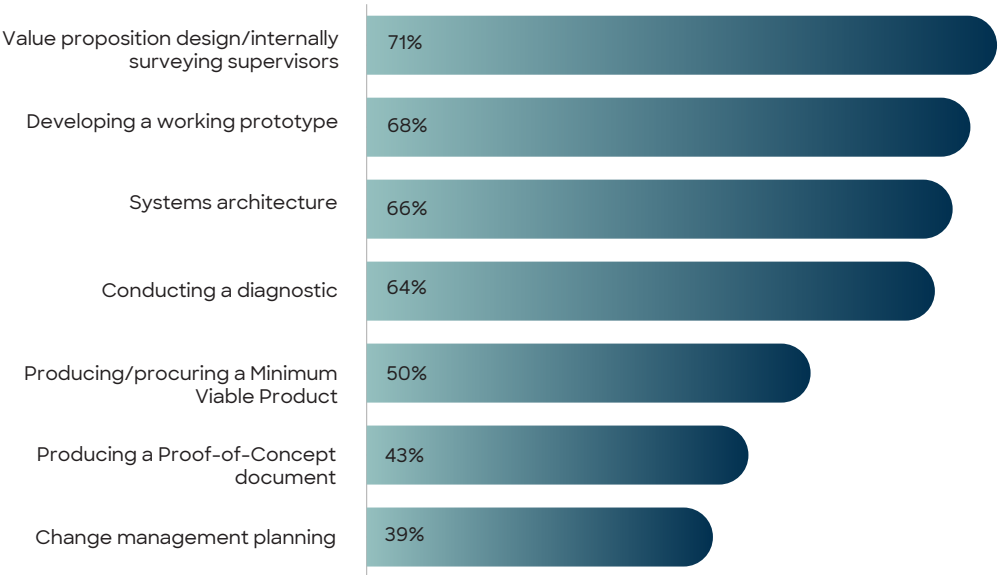
A smaller segment, 6.6%, adopts the “mechanistic” approach, methodically upgrading legacy systems with new technology components. This approach

offers a progressive transition towards more advanced suptech capabilities.

Conversely, the “ringfenced” approach has seen minimal adoption, accounting for only 1.6% of financial authorities. This approach focuses on developing greenfield solutions that minimise dependencies on existing systems. It involves creating entirely novel experiments with independent infrastructures that later integrate with national efforts, such as those undertaken by the BIS Innovation Hub (BISIH) in projects like [Ellipse](#) and [Aurora](#). While offering valuable proof of concept for future suptech infrastructure possibilities, this approach can sometimes fall short in addressing the nuanced and immediate supervisory challenges specific to individual financial authorities due to its experimental nature.

FIGURE 65.

WHICH OF THE FOLLOWING DESIGN STEPS DOES THE AGENCY UNDERTAKE OR IS UNDERTAKING IN THE DESIGN OF YOUR SUPTECH APPLICATION? (N=44)



While a majority of financial authorities actively participate in supervisor-centred design processes during the development of suptech applications, there remains a notable shortfall in the area of change management planning, which is a critical aspect for the comprehensive digital transformation that underpins widespread suptech adoption.

Financial authorities are adopting a variety of approaches in the design of suptech applications, with an increasing focus on human-centred design (HCD) principles and a [supervisor-centred](#) design framework. This approach ensures a deep understanding of the end-users, particularly supervisors, to create intuitive and effective applications.

To begin, financial authorities are conducting diagnostics (64%) and value proposition design (70%), surveying supervisors internally to tailor technology solutions to their specific needs and expectations. This alignment is crucial for

the effectiveness of suptech solutions in real-world supervisory contexts.

Once a value proposition is determined, system architecture becomes key in identifying integration points with existing processes and legacy systems. 66% of respondents use this approach for a comprehensive understanding of technological integration and to maintain adaptability in suptech applications.

As the design phase transitions to development, agile methodologies are prominently used, with 50% of authorities developing Minimum Viable Products (MVPs) to rapidly address essential needs. The agile approach's iterative nature is further demonstrated by 68.2% of respondents creating working prototypes for frequent feedback and refinement.

However, a notable 32% of respondents do not incorporate human-centred design elements in their development process. This could either indicate the adoption of alternative methodologies or a lack of emphasis on user-centric design. Such an approach could lead to less effective and user-friendly solutions, as seen in the

success of the [ECB's suptech innovations](#), which were driven by a user-centric, staff-led approach where frontline supervisors' needs were central.

In summary, while most financial authorities are increasingly adopting human-centred design philosophies in suptech development, there remains a significant portion that has yet to integrate these essential principles, potentially impacting the effectiveness and user-friendliness of the developed suptech solutions.

Financial authorities aiming to incorporate design thinking in suptech face several key challenges, including time constraints, a lack of sufficient expertise in design thinking principles and methodologies, and the siloing of perspectives within organisations that can restrict the collaborative, cross-functional approach that design thinking necessitates.

Financial authorities navigating the

design of suptech applications face several significant challenges, reflecting the complexity of integrating technology within supervisory functions. A primary challenge is the time required to produce effective suptech solutions (63.5%). This involves balancing the urgency for deployment with ensuring functionality, security, and compliance. Aligning the organisation's culture to embrace design thinking and agile methodologies is another significant hurdle (58.7%). This may require considerable shifts in organizational culture to fully leverage the benefits of human-centred design.

Furthermore, many financial authorities struggle with insufficient internal skills and knowledge in product design (52.4%). This gap necessitates collaboration with external experts to facilitate sophisticated development processes. Another notable challenge is the limited ability for knowledge or data sharing across different teams or departments within the organisation (44.4%), which can impede the integration and effectiveness of suptech solutions.

Addressing these challenges requires a comprehensive strategy that includes

FIGURE 66.
WHAT CHALLENGES DOES THE AGENCY FACE IN USING THESE DESIGN STEPS? SELECT ALL THAT APPLY. (N=63)



capacity building to enhance internal skills, cultural transformation to foster a more agile and collaborative work environment, and improved mechanisms for interdepartmental communication and data sharing. These strategies, as detailed in section 3.4 of this report, are vital for financial authorities to effectively manage the complexities of suptech integration and to leverage its full potential in enhancing supervisory process.

For financial authorities in AEs, a significant challenge in adopting supervisor-centred design is the difficulty in attracting and retaining the necessary talent. This issue is more pronounced in AEs compared to their counterparts in EMDEs. The competitive job market in AEs often makes it challenging for financial authorities to find and keep individuals with the specialised skills required for effective suptech implementation.

In contrast, financial authorities in EMDEs face distinct challenges, particularly in terms of sharing knowledge or data across different teams. These constraints can be attributed to factors like limited technological infrastructure, organisational silos, and a lack of integrated data systems. Such barriers hinder the flow of information and collaboration within these organisations, posing significant obstacles to the effective design and implementation of suptech solutions.

Considering the findings presented in section 3.4.5 of this Report, which underscore a disproportionately high demand from EMDE financial authorities for external support in through training programs, technical assistance, access to digital tools, and funding, it is critical to develop capacity building and technical assistance programs for EMDEs to overcome their challenges in this area.

FIGURE 67.
WHAT CHALLENGES DOES THE AGENCY FACE IN USING THESE DESIGN STEPS? (N=63)
 SEGMENTED BY ECONOMIC STATUS

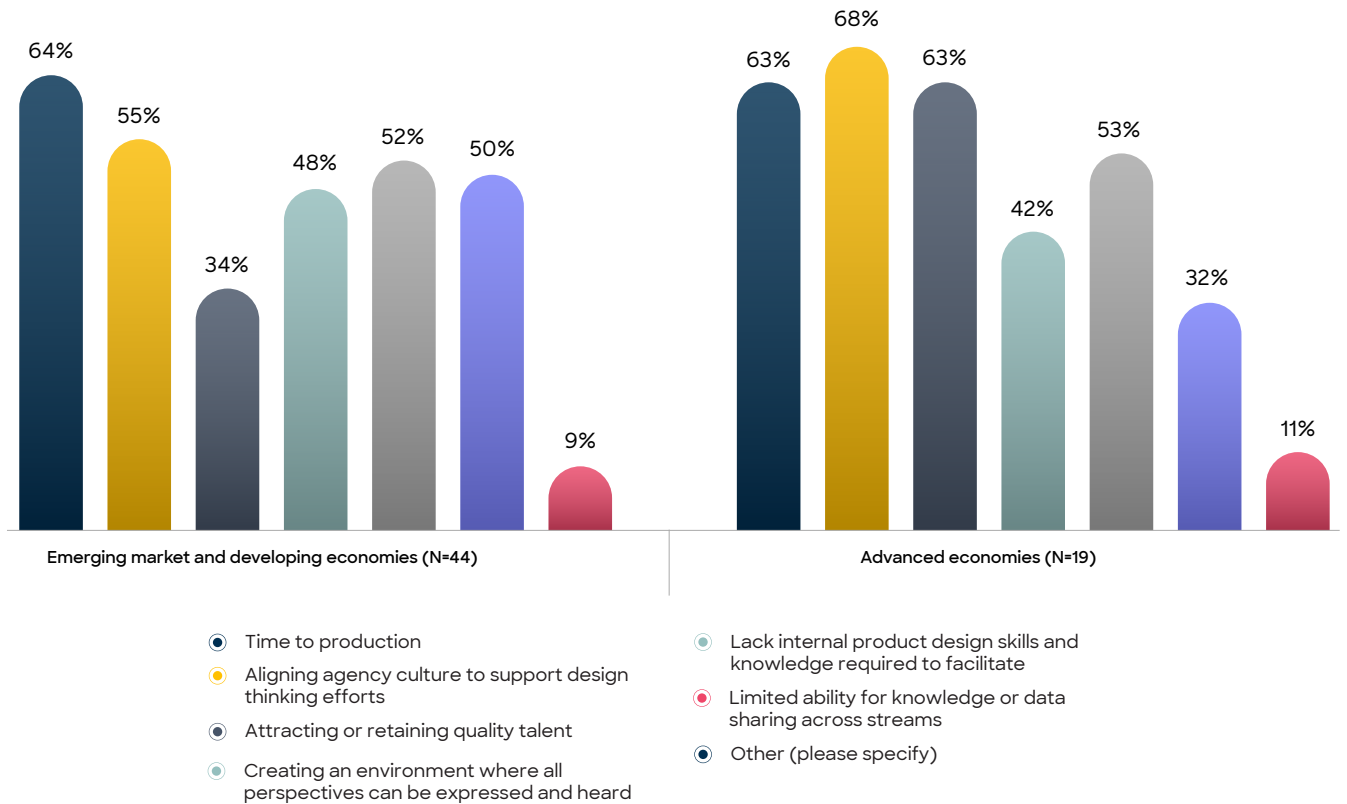
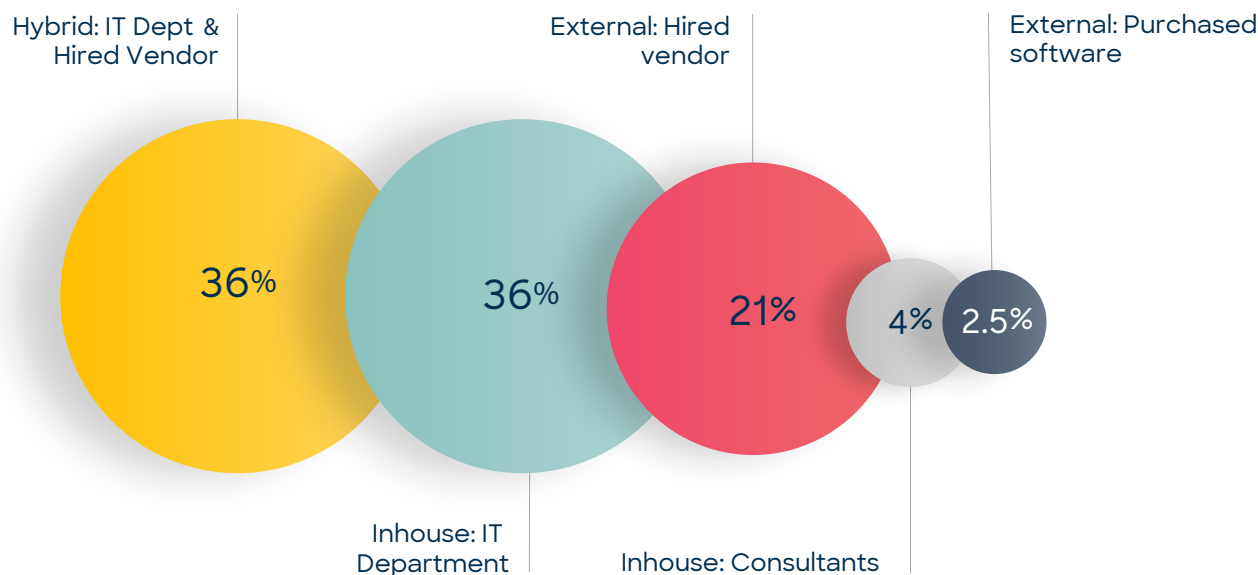


FIGURE 68.

HOW ARE THESE APPLICATIONS BEING DEVELOPED? (N=42)



“Build versus buy” is a false dichotomy, and financial authorities employ strategies from all across this spectrum to develop supotech solutions.

Transitioning from the design to the implementation of supotech applications involves a complex decision-making process, where financial authorities must weigh various factors to determine the most effective development approach. Key considerations include the urgency of time to production, the readiness of internal IT capabilities, and the cultural dynamics influencing the adoption of design thinking methodologies.

The urgency of time to production often dictates whether financial authorities should rely on their internal IT departments or seek external vendor support. This becomes especially critical in scenarios requiring rapid deployment of supotech solutions. Concurrently, aligning organisational culture to support innovative design thinking efforts is pivotal

and can significantly influence the choice of development approach. This alignment is crucial to ensure that new technologies are not only developed efficiently but are also embraced and effectively used by the supervisory staff.

In-house development necessitates a continuous investment in skill enhancement, particularly for technologies like machine learning that require consistent monitoring, updating, and refinement. Ensuring that internal teams are equipped with the latest skills and knowledge is essential for the successful development and maintenance of these advanced solutions.

Contrary to the traditional ‘build versus buy’ dichotomy, the reality for most financial authorities is a hybrid approach that utilises both internal and external resources. This approach, reported by 36% of respondents, highlights the versatility and adaptability required in the rapidly evolving supotech landscape. It suggests a spectrum of development options, combining the strengths of

in-house capabilities with the expertise of external vendors and technologies.

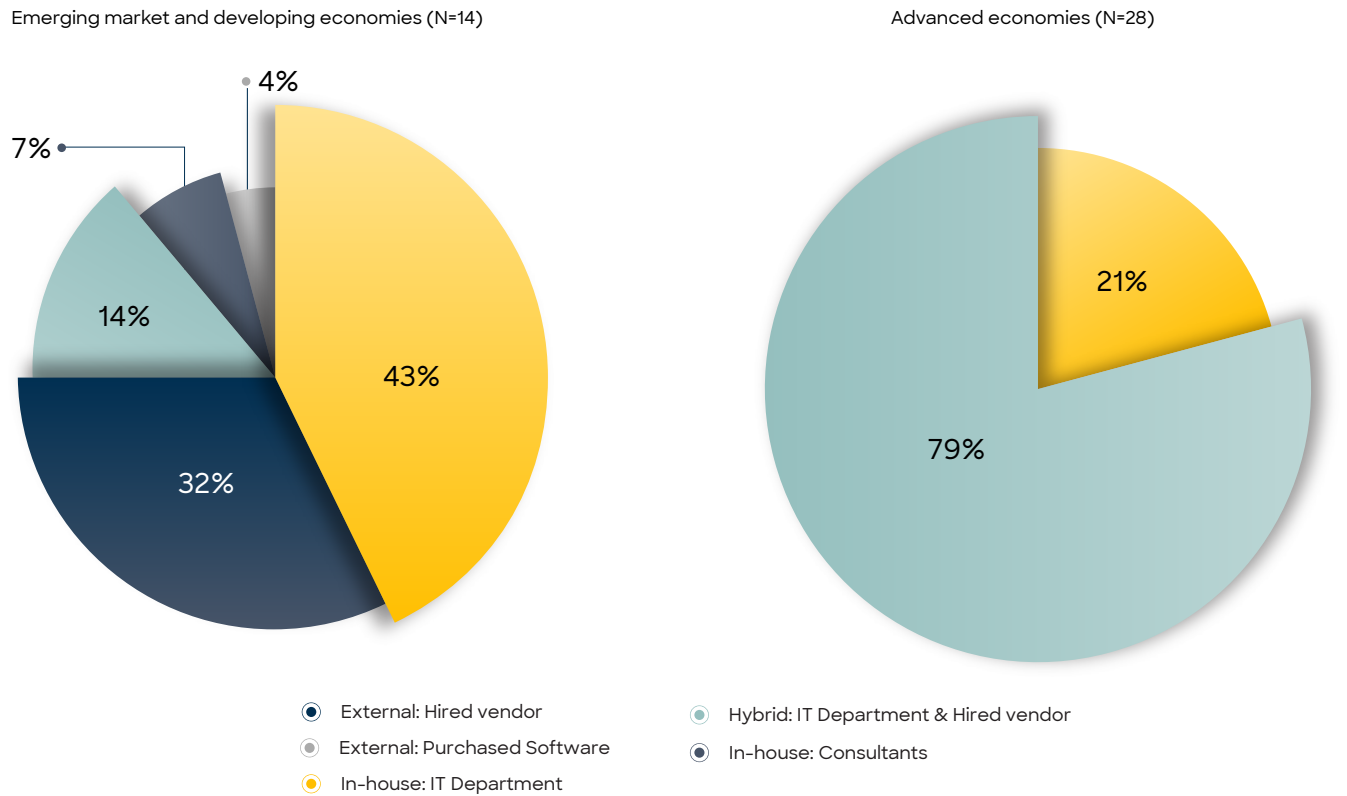
Significant activity is also observed at both ends of this spectrum. A notable proportion of financial authorities develop suptech solutions purely internally, leveraging their IT departments (36%) and engaging consultants (5%). On the other hand, many authorities opt for external resources, including hiring vendors (21%) and implementing off-the-shelf software (2%).

These trends reflect a diverse landscape in suptech development, where financial authorities tailor their approaches based on their specific needs, capabilities, and strategic objectives. As the field of suptech continues to evolve, these decisions will remain crucial for the effective and efficient implementation of technology-driven supervisory tools.

Financial authorities in AEs always dedicate at least some internal resources to development of suptech solutions, whereas their EMDE counterparts more frequently rely exclusively on external vendors and off-the-shelf software.

In breaking this down by economic status, we note a massive disparity in how solutions are developed by financial authorities. Financial authorities in AEs report having some in-house component 100% of the time, and exclusively working in-house 79% of the time. In stark contrast, authorities in EMDEs report something much closer to the hybrid approach in the “build versus buy” dichotomy, with exclusive in-house development 43% of the time and exclusive use of vendors reported in 32% of the cases.

FIGURE 69.
HOW ARE THESE APPLICATIONS BEING DEVELOPED? (N=42)
SEGMENTED BY ECONOMIC STATUS



In addition to an increased reliance on external funding, authorities in EMDEs depend on vendors from AEs, which brings representation issues along with potential resulting algorithmic fairness implications.

A separate analysis of the Cambridge SupTech Lab’s [SupTech Marketplace](#) showed that the vast majority of vendors hail from AEs. The implication is that authorities in AEs have solution providers not only from AEs, but from within their own organisation. Conversely, authorities in EMDEs often depend on vendors from AEs.

This disparity has incredibly important implications for topics such as algorithmic fairness, which starts with having a representative leadership to build and oversee such solutions. This shows up in the challenges section of this report, where authorities in EMDEs express larger

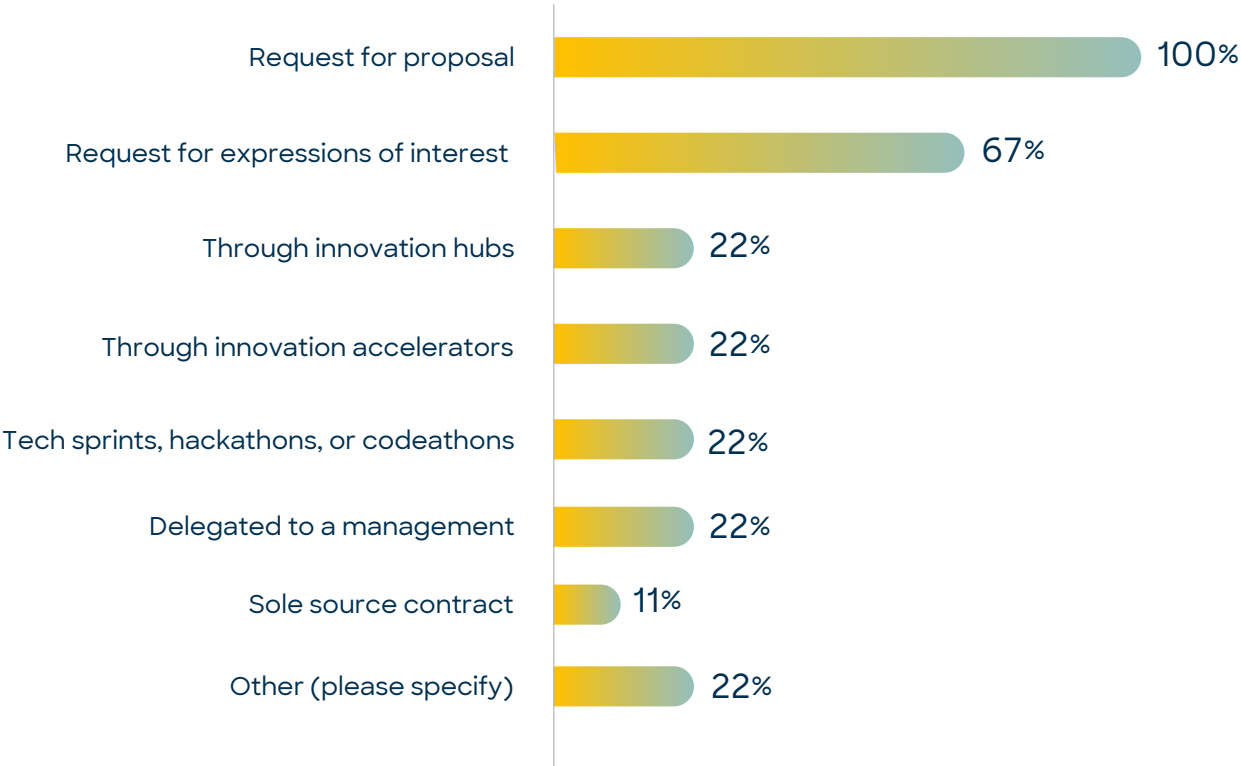
concerns than AE peers when it comes to data manipulation by third parties and lack of representativeness of the incoming data.

There is a need for support of more in-market suptech vendors in EMDEs.

One obvious, potential implication is a need for concrete support in incubating and accelerating vendors in EMDEs to better serve EMDEs.

Ultimately, whether opting for the in-house expertise of IT departments, and/or leveraging external vendor capabilities, financial authorities face the ongoing challenge of striking a balance between customisation, cost-effectiveness, and agility in suptech implementation.

FIGURE 70.
HOW DOES YOUR AGENCY ENGAGE WITH VENDORS? (N=9)



Lean engagement models are emerging.

Financial authorities seeking to leverage external resources for supotech have a range of engagement mechanisms at their disposal. Predominantly, traditional procurement methods such as Requests for Proposal (RFP), used by all respondents, and Requests for Expressions of Interest (REOI), used by 66.7%, continue to be the primary methods of engaging external vendors. These conventional practices are well-established, providing a structured and familiar pathway for vendor selection.

However, a smaller proportion of financial authorities, about 22%, are exploring [innovative engagement models](#) like hackathons, techsprints, innovation accelerators, and innovation hubs. These modern approaches offer a dynamic and interactive platform for vendor engagement, fostering creativity and innovation. The hesitation among some financial authorities to fully embrace these newer models may stem from various factors such as legal or regulatory constraints, risk aversion, or perceived complexities and resource requirements compared to traditional methods.

Despite these challenges, there's a growing trend in supplementing traditional procurement with these innovative engagement mechanisms. The Lab's Launchpad model exemplifies this, where several financial authorities have successfully used competition models to select vendors for developing and testing prototype supotech solutions. These methods are further detailed through case studies in section 4 of the report, showcasing their effectiveness in fostering innovative solutions.

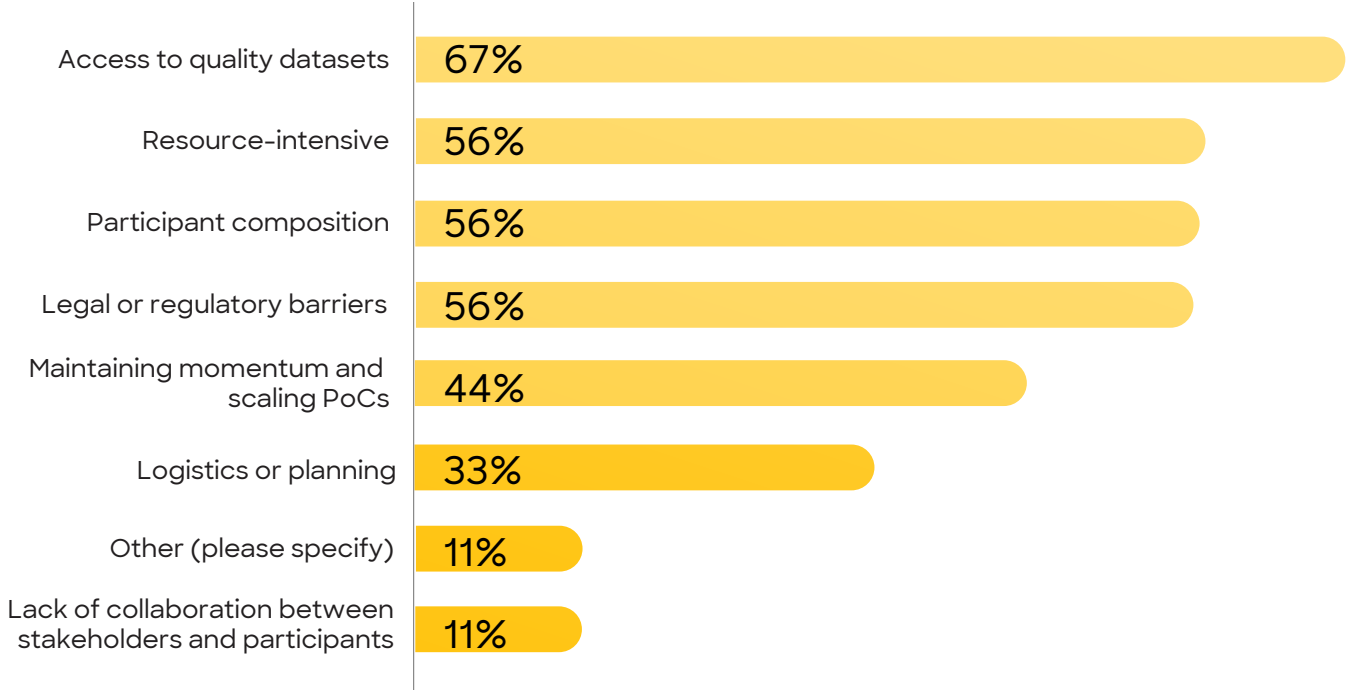
The choice of engagement model depends on several factors, including the specific requirements of the project, the size and expertise of the potential vendor pool, the scope of work, and the

time and cost commitments involved. Open-ended competition models like data competitions are suitable for projects requiring innovative solutions with unpredictable outcomes, though they bear the risk of deviating from the initial project requirements. In contrast, RFPs may be more fitting for projects with well-defined parameters, but they often attract traditional vendors and may limit innovation.

Time and cost considerations also play a significant role in selecting an engagement model. Quick-result-oriented models like hackathons or datapaloozas are effective for generating preliminary designs or proofs of concept. On the other hand, accelerators provide a structured approach, guiding a product or solution from its conceptual stage to finalisation, ensuring sustained progress and more comprehensive development.

FIGURE 71.

WHAT CHALLENGES DID THE AGENCY FACE IN USING THESE ENGAGEMENT MODELS?
(N=9)



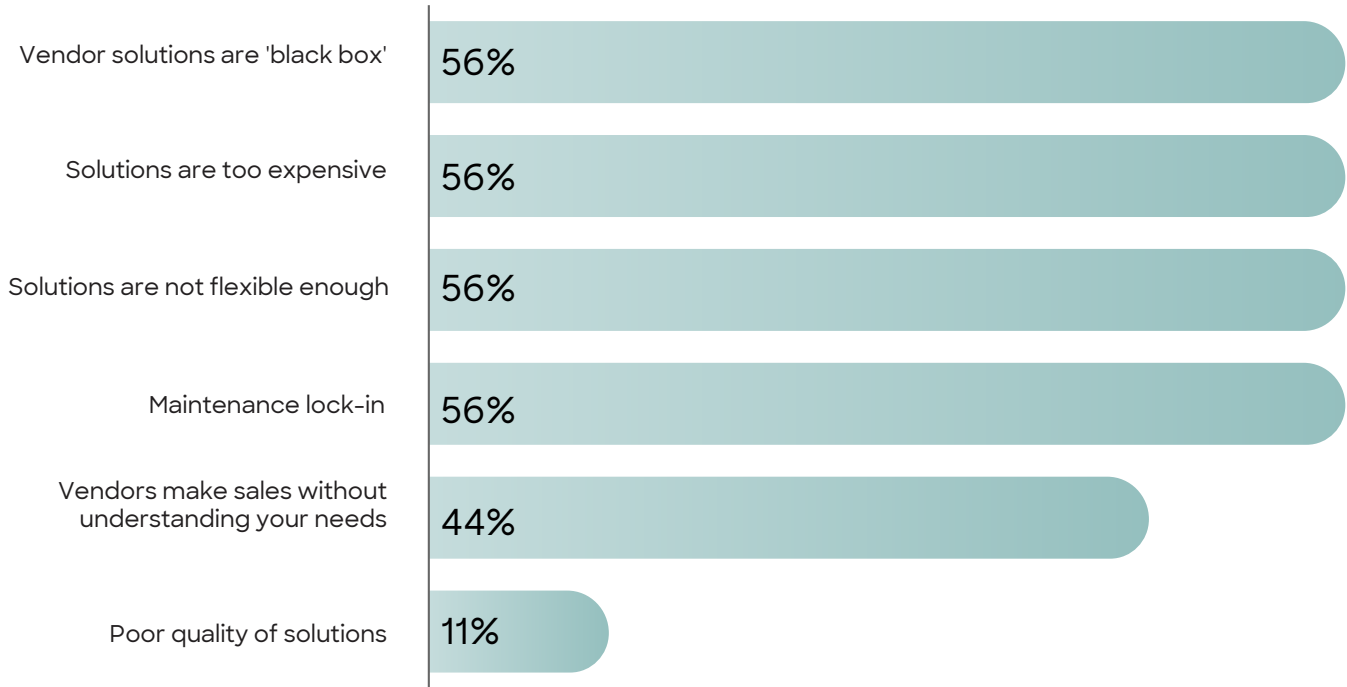
Financial authorities experience a variety of challenges across vendor engagement models, which stand to be addressed by centralised, ecosystem-wide resources and events.

Producing supotech solutions through the various methodologies requires addressing distinct challenges for financial authorities. Respondents reported that they encounter obstacles in reliable access to quality datasets (67%), and challenges with the resource-intensive nature of these initiatives (56%). The delicate composition of a diverse and interdisciplinary set of participants in the development process (56%), legal or regulatory barriers (56%) and the ongoing challenge of maintaining momentum while scaling proof-of-concept projects (44%), were also noted as significant challenges.

Initiatives such as the Lab’s [Hackathon](#) approach, the Alliance for Innovative Regulation (AIR) tech challenges, and FCA techsprints aim to mitigate these challenges to some level of success. By formalising this approach and bringing the broader ecosystem together around an event, quality datasets can be concentrated, costs can be distributed, participation diversified, and regulatory barriers collectively addressed. Such approaches create efficiencies in holding such events, while often producing richer, more well-tested results than similar modes executed in isolation.

FIGURE 72.

WHAT CHALLENGES DID THE AGENCY FACE IN ENGAGING WITH VENDORS? (N=9)



Challenges experienced by financial authorities in engaging with vendors include a lack of transparency or flexibility (i.e., a “black box” problem), costs, and lock-in.

Moving past the initial engagement, ideation, and competition stages, an investigation of the set of challenges financial authorities directly face when engaging with vendors to develop supotech solutions can prove useful in identifying and working toward addressal of such issues.

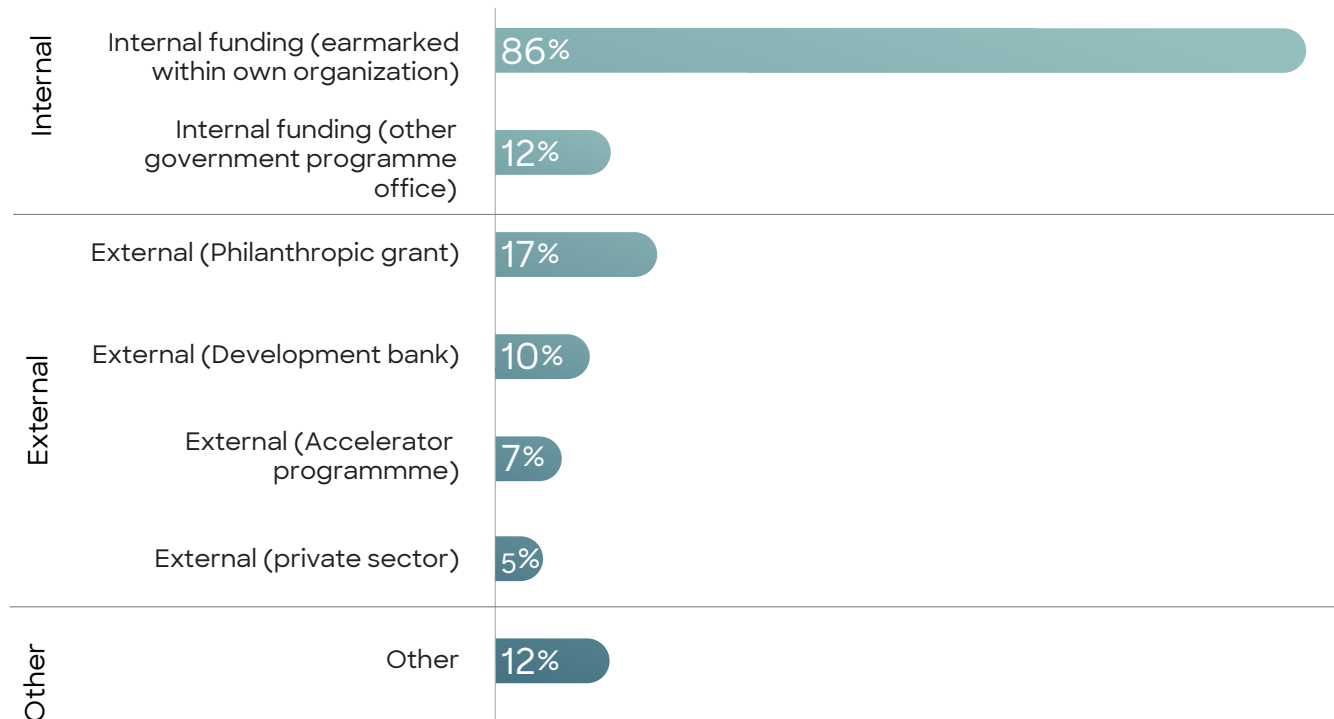
The majority of the responding authorities grapple with complexities such as vendor solutions operating as “black boxes” (55.6%). The same proportion of respondents cite the potential prohibitive cost of solutions, the inflexibility of some offerings, and concerns surrounding maintenance lock-in. An additional 44.4% also reported challenges with

vendors prioritising sales over a deep understanding of financial authorities’ needs.

These challenges underscore the multifaceted nature of supotech development, demanding a nuanced and strategic approach to balance innovation with practical considerations and effective vendor collaboration. Whether accomplished via internal innovation initiatives or in coordination with initiatives like the BIS Innovation Hub or the Lab’s Launchpad, allowing for fluid communication and iterative development throughout the engagement is critical.

FIGURE 73.

WHAT IS THE SOURCE OF FUNDING FOR THE DEVELOPMENT AND DEPLOYMENT OF YOUR SUPTECH APPLICATION(S)? (N=42)



Of course, all of these initiatives require funding. Far and away, the primary funding source for the development and implementation of supotech applications originates from internal funding, specifically earmarked within the respective organisations (85.7%).

This internal financing approach might underscore a commitment to self-sufficiency and financial autonomy among financial authorities with the available budget to invest in this area. By allocating resources from their own budgets, these authorities maintain control over the strategic direction and pace of supotech development, allowing for a more customised and responsive implementation process.

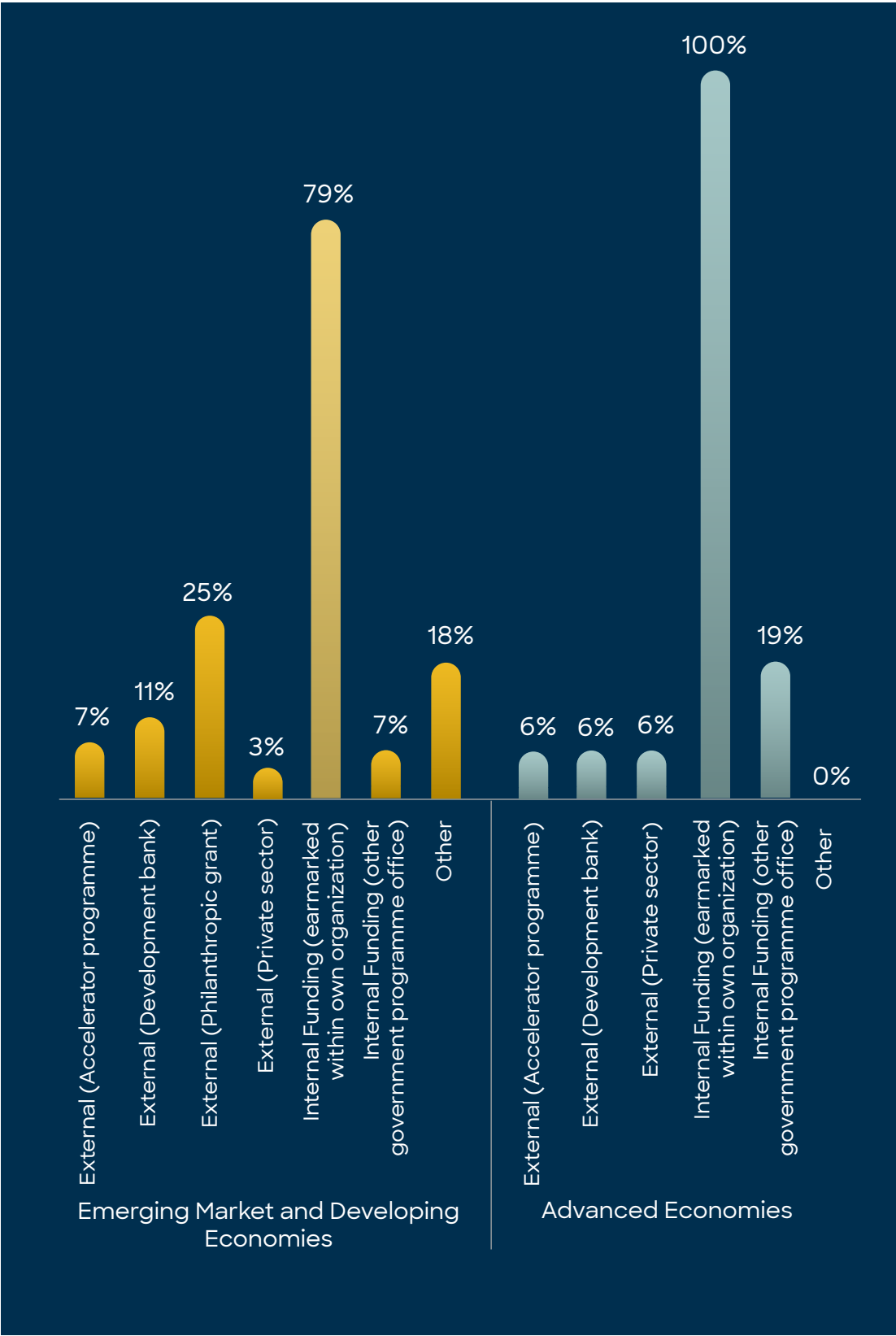
However, this internal funding approach may have limitations, particularly in cases where financial constraints hinder the

realisation of broader and more ambitious supotech initiatives, especially for financial authorities already facing resource constraints.

In any case, balancing the potential advantages and constraints of internal versus external funding necessitates a judicious assessment of financial capacities and strategic priorities to ensure the sustained evolution of supotech capabilities.

FIGURE 74.

WHAT IS THE SOURCE OF FUNDING FOR THE DEVELOPMENT AND DEPLOYMENT OF YOUR SUPTECH APPLICATION(S)? (N=42)
SEGMENTED BY ECONOMIC STATUS



While internal budgets are the primary source of funds for authorities in both EMDEs and AEs, those in EMDEs depend much more strongly on external, philanthropic grants to develop solutions.

While authorities from both AEs and EMDEs predominantly depend on internal funding to support their suptech initiatives, there is a notable gap. While 100% of authorities in AEs leveraged some internal funding, only 78% from EMDEs were able to do so. Relatedly, 25% of agencies in EMDEs reported receiving external funding through philanthropic grants, while this figure is 0% in AEs.

In light of this evidence, it becomes apparent that in EMDEs, financial authorities’ ability to achieve suptech goals in a timely manner relies on external funding sources such as philanthropic grants, development bank funding, and government grants. An analysis of survey responses on challenges in section 3.6 supports this hypothesis, revealing a positive correlation between agencies reporting budgetary constraints and their incorporation of external funding sources.

3.6. Suptech challenges and risks

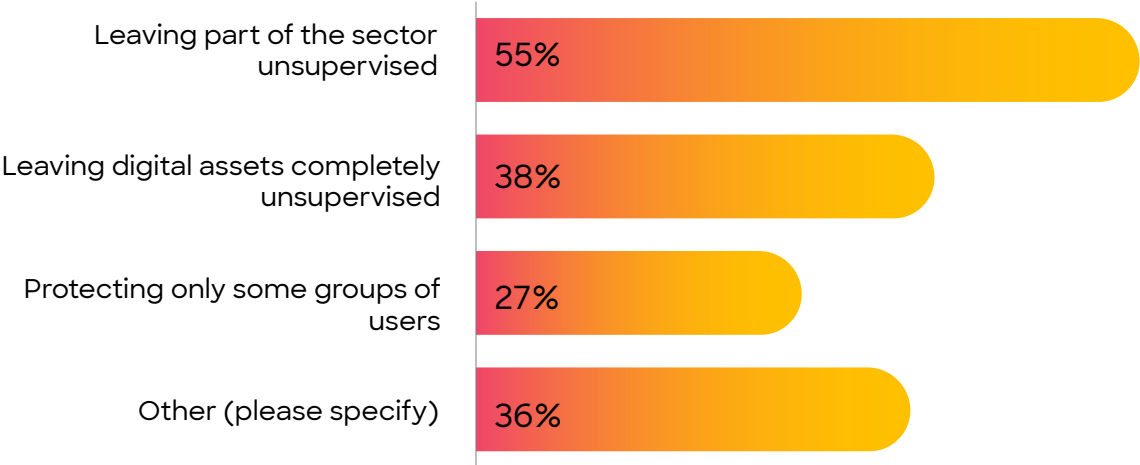
As financial authorities increasingly embrace technological advancements to enhance supervisory processes, it becomes imperative to explore the nuanced complexities that accompany such transitions. This section of the report aims to provide a comprehensive overview of the challenges encountered by financial authorities, offering valuable insights into the perceived risks that may arise during the deployment of suptech solutions.

By delving into these hurdles, we aim to foster a deeper understanding of the obstacles faced by financial authorities and provide a foundation for informed strategies to navigate and overcome these challenges in the dynamic intersection of technology and financial supervision.

Financial authorities report that operating without suptech introduces significant risks into their supervisory landscape.

Among the highest risks identified are the potential of leaving parts of the financial sector unsupervised, which could result

FIGURE 75.
WHAT ARE THE RISKS THAT YOUR AGENCY FACES TODAY? (N=55)



in unmitigated risks and supervisory blind spots.

Additionally, the lack of adequate suptech measures poses a threat to allowing digital assets to remain entirely unsupervised, heightening the vulnerability to cyber threats and financial crimes within the digital realm. Moreover, the risk of only protecting specific groups of users raises concerns about potential inequalities and gaps in supervisory coverage, highlighting the need for comprehensive and inclusive supervisory approaches.

These identified risks underscore the critical role that suptech plays in addressing supervisory challenges, enhancing oversight, and fortifying the financial ecosystem against emerging threats.

The development of suptech continues to face a myriad of challenges for financial authorities, encompassing both internal constraints and external impediments, which are reported to have increased since last year.

FIGURE 76.
WHAT CHALLENGES HAS YOUR AGENCY FACED IN DEVELOPING SUPTECH INITIATIVES?
(N=55)
2022 VS 2023

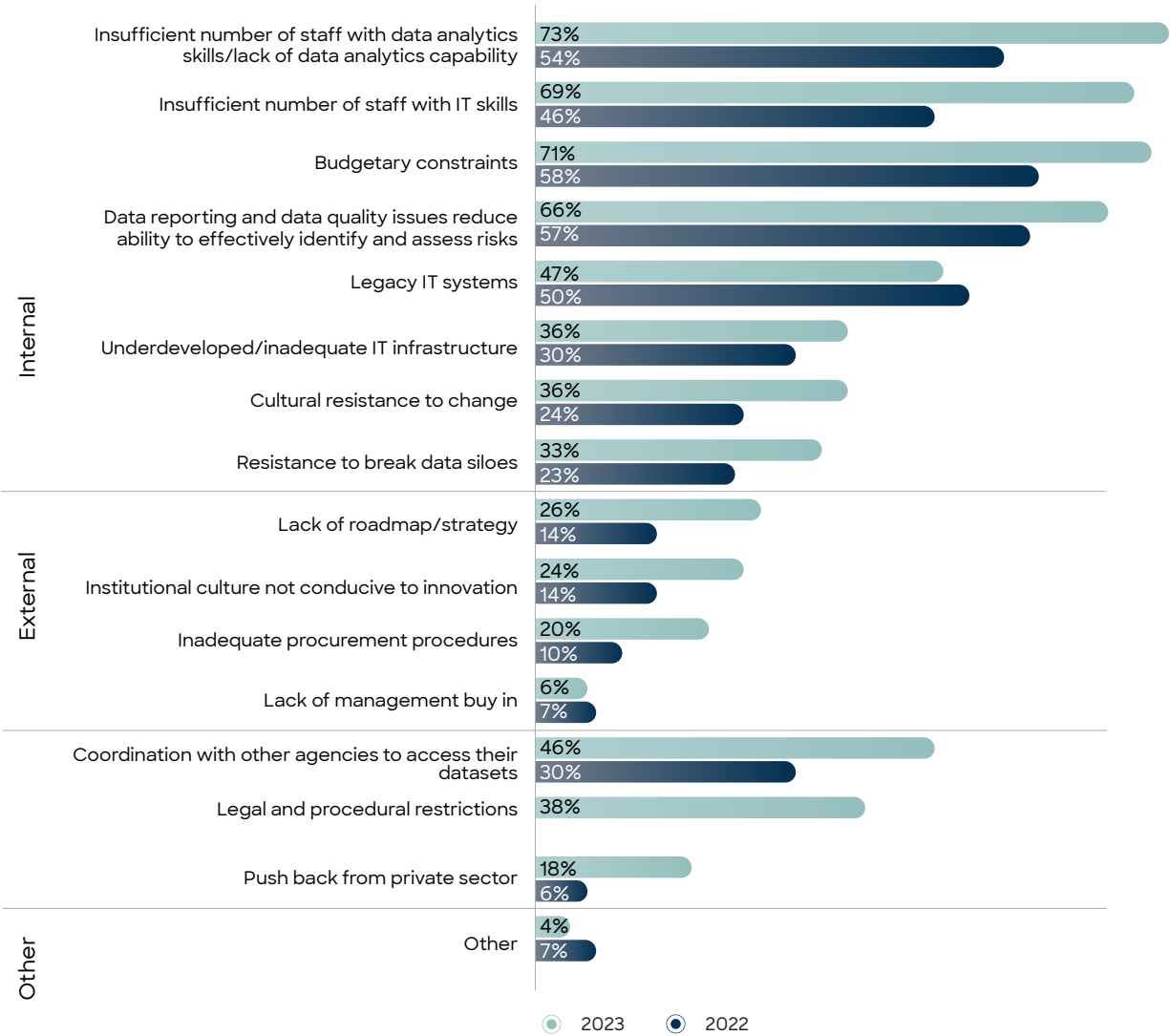
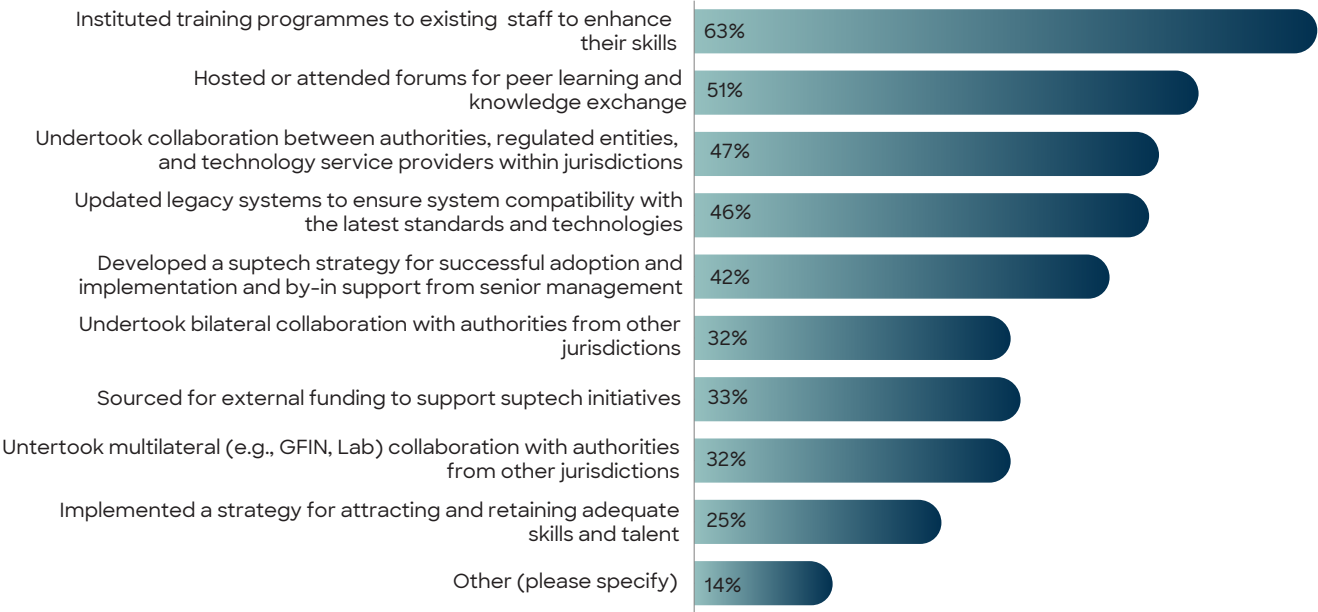


FIGURE 77.

WHICH OF THE FOLLOWING ACTIONS HAS YOUR AGENCY UNDERTAKEN IN RESPONSE TO THESE CHALLENGES? (N=55)



Similar to last year, financial authorities continue to grapple with formidable hurdles such as a shortage of adequately trained personnel possessing essential IT skills and data analytics capabilities, limited financial resources, data reporting and quality issues, and limitations of legacy systems. Externally, financial authorities continue to face the intricate task of coordinating with other agencies to access diverse datasets and a few reported legal and procedural restrictions.

There is notably an increase since last year in the share of authorities identifying such challenges overall. A portion of this could be attributed to the overall increase in the share of authorities who are engaging in suptech, and thus experiencing these challenges. The fact that there are new tools for diagnosing such challenges (e.g. the Lab’s [Digital SupTech Diagnostic Tool](#)) may also play a role in increasing a more nuanced awareness of such challenges.

Mitigation strategies for these challenges involve trainings, peer engagement and collaboration,

tech upgrades, and strategy development.

This year has brought to the forefront a notable surge in challenges attributed to the scarcity of staff equipped with IT skills and data analytics capabilities within financial authorities. The heightened demand for technological expertise in the rapidly evolving landscape of suptech has underscored the critical importance of addressing this staffing shortfall.

Acknowledging the formidable challenges posed by the shortage of staff equipped with IT skills and data analytics capabilities, financial authorities have proactively implemented a series of strategic initiatives. Training programs have been instituted to uplift the skill set of existing staff (63.2%), providing them with the necessary expertise to navigate the complexities of suptech.

To support a multifaceted strategy, financial authorities can also actively recruit individuals with requisite expertise and strengthen the workforce, they

can establish internship programs and create opportunities for practical experience further cultivating a skilled talent pool. One such initiative is the [Innovation Leaders Residency](#) programme at the Lab which aims to equip and empower a new generation of financial supervisors to accelerate the digital transformation of financial supervision within their agencies and become global suptech ambassadors.

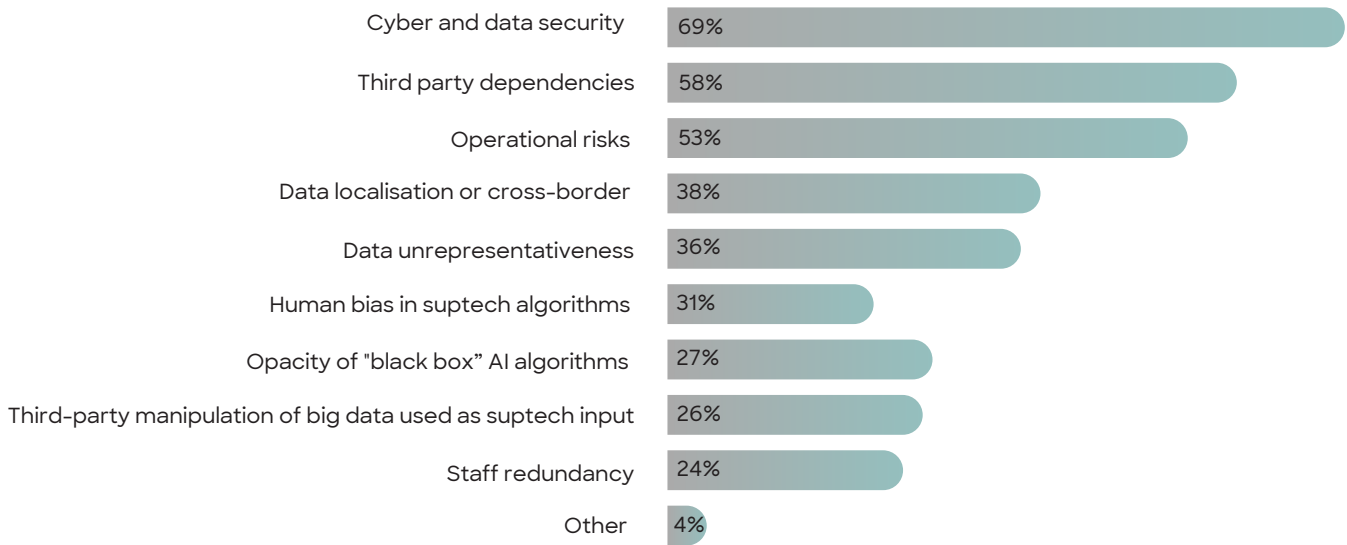
In an effort to learn from their peers' successes and failures, financial authorities have participated in and even hosted forums for peer learning and knowledge exchange (50.9%), fostering an environment where insights and best practices can be shared among industry professionals. This may include online forums such as the [Regulator Knowledge Exchange \(RKE\)](#), live events such as the BIS Irving Fisher Committee's annual [Data Science in Central Banking](#) workshops, and virtual events such as [SupTech Week](#). To extend beyond this exchange among peers, and to enhance collaboration and address the multifaceted challenges, authorities have undertaken partnerships between regulatory bodies, regulated entities, and technology service providers

within jurisdictions (47.4%). By adopting this holistic approach, financial authorities can effectively address the scarcity of IT and data analytics skills, positioning themselves to navigate the challenges of developing and implementing suptech initiatives successfully.

Beyond the challenges associated with the development of suptech, financial authorities also acknowledge and anticipate inherent risks tied to its adoption.

Foremost among these concerns is the ever-pressing challenge of cyber and data security (69.1%). The rise in cyber-attacks is increasingly pronounced, with supervisory processes transitioning to digital platforms. This susceptibility to cyber attacks is heightened as various areas become more interconnected, and platforms are either opened or shared. The increased reliance on technology and digital solutions widens the scope and number of entry points for potential cyber threats. Consequently, suptech activities may elevate the overall vulnerability of supervisory agencies to cyber risks.

FIGURE 78.
WHAT RISKS HAS YOUR AGENCY FACED OR ANTICIPATES IN ADOPTING SUPTECH INITIATIVES? (N=55)



The reliance on third-party dependencies (58.2%) introduces another layer of risk. As the shift toward multi-component, composed systems of vendor solutions accelerates, the consequences of such collaboration also grow in magnitude. Dependencies on an external entity to incorporate feedback can potentially lead to delays. In particular, when dealing with insufficient or malfunctioning internal systems, controls, procedures, or policies due to breaches, fraud, or external events, such delays can significantly disrupt the operations of financial authorities. Such considerations may be taken into account up front when preparing contracts and service level agreements with solution providers.

Additionally, there is a significant emphasis on operational risks (52.7%), with authorities being vulnerable to operational challenges arising from outsourcing solutions to algorithm and cloud computing providers. Additionally, the growing dependence on digital tools may result in heightened interdependencies and interconnected systems, amplifying the potential severity of impacts in the event of glitches. These acknowledged risks underscore the importance of a comprehensive risk management framework to ensure the resilience and security of the financial ecosystem.

Finally, and notably, we see a novel family of identified risks arising with the emergence of advanced data analytics, which comprise a concern for potential algorithmic and data biases including skewed data, human biases in algorithms, and “black box” algorithms.

In segmenting by economic status to examine the same risks encountered or foreseen in the adoption of supotech between financial authorities in AEs and EMDEs notable distinctions emerge.

In AEs, a higher proportion of agencies contend with or anticipate risks related

to third-party dependencies (76.5%) and concerns stemming from opacity in AI algorithms (52.9%), compared to 50% and 15.8%, respectively, in EMDEs.

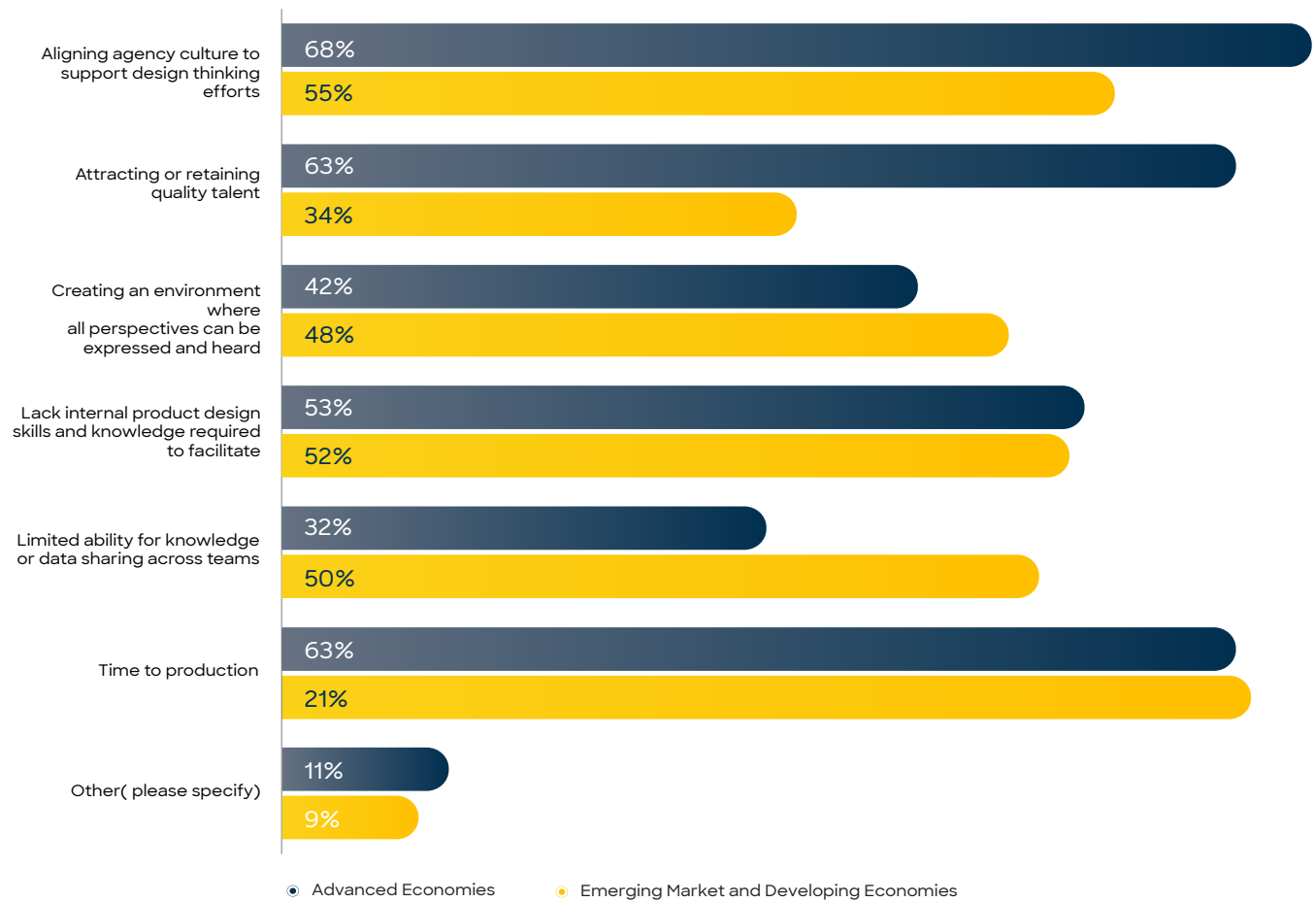
Conversely, in EMDEs, a greater number of agencies confront operational risks (65.8%) and risks associated with non-representative data (44.7%), in contrast to 23.5% and 17.7% in AEs, respectively.

It is important to recall from earlier in the report that authorities in AEs work exclusively with teams involving in-house colleagues, while EMDEs often work with external vendors, who largely hail from AEs. The operational risks and risks associated with non-representative data seem to be obviously connected to this discrepancy, and further underscores the need for a deepening of the marketplace of vendors from EMDEs to serve these authorities.

FIGURE 79.

WHAT RISKS HAS YOUR AGENCY FACED OR ANTICIPATES IN ADOPTING SUPTECH INITIATIVES? (N=55)

SEGMENTED BY ECONOMIC STATUS



4.

CASE STUDIES

SUPTECH APPLICATIONS

This curated collection of case studies encompasses a wide range of supervisory areas, showcasing diverse applications of suptech solutions. These projects have been selected to reflect the various layers outlined in the SupTech Taxonomy, found in Appendix 2 of this Report.

Each case study, while unique in its application, may employ technologies that have broader applicability across different supervisory domains. For instance, a data collection tool using Application Programming Interfaces (APIs) could be adapted for use in multiple supervisory contexts. However, for clarity and focus, each case study is categorised based on the supervisory area where its primary innovation was initially implemented.

To further assist financial authorities in exploring these suptech solutions, the Cambridge SupTech Lab has established the [SupTech Marketplace](#). This comprehensive online database serves as a valuable resource, providing detailed information and insights into various suptech tools and applications. It offers an extensive overview of the solutions developed across different supervisory areas, facilitating the exploration and adoption of innovative suptech applications tailored to specific supervisory needs.

4.1. Consumer protection and market conduct supervision: Cambridge SupTech Lab's Launchpad 2023 solutions

In 2022, teams from the Bangko Sentral ng Pilipinas (BSP), the Securities and Exchange Commission (SEC) Philippines, the Bank of Ghana (BOG), the Superintendence of Banking, Insurance and Private Pension Funds Administrators of Peru (SBS) (and the Indonesian Otoritas Jasa Keuangan (OJK) engaged in the Cambridge SupTech Lab Capacity Building & Education programme and developed five proof-of-concepts (POCs) aimed at creating three innovative suptech solutions:

- A financial consumer protection suite with web scraper and machine learning (ML)-based analysis.
- A next-generation artificial intelligence (AI)-powered, chatbot supported, complaints management system.
- A platform for financial market monitoring via social media and web extraction.

By 2023, with support from the Bill & Melinda Gates Foundation, the Lab extended its partnership to include these five agencies and three vendors for the development of working prototypes, each incorporating elements of web scraping and public sentiment topic modelling.

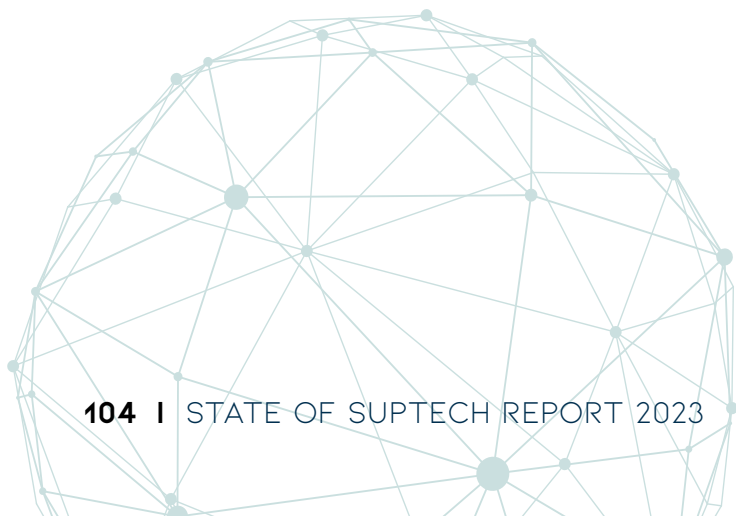
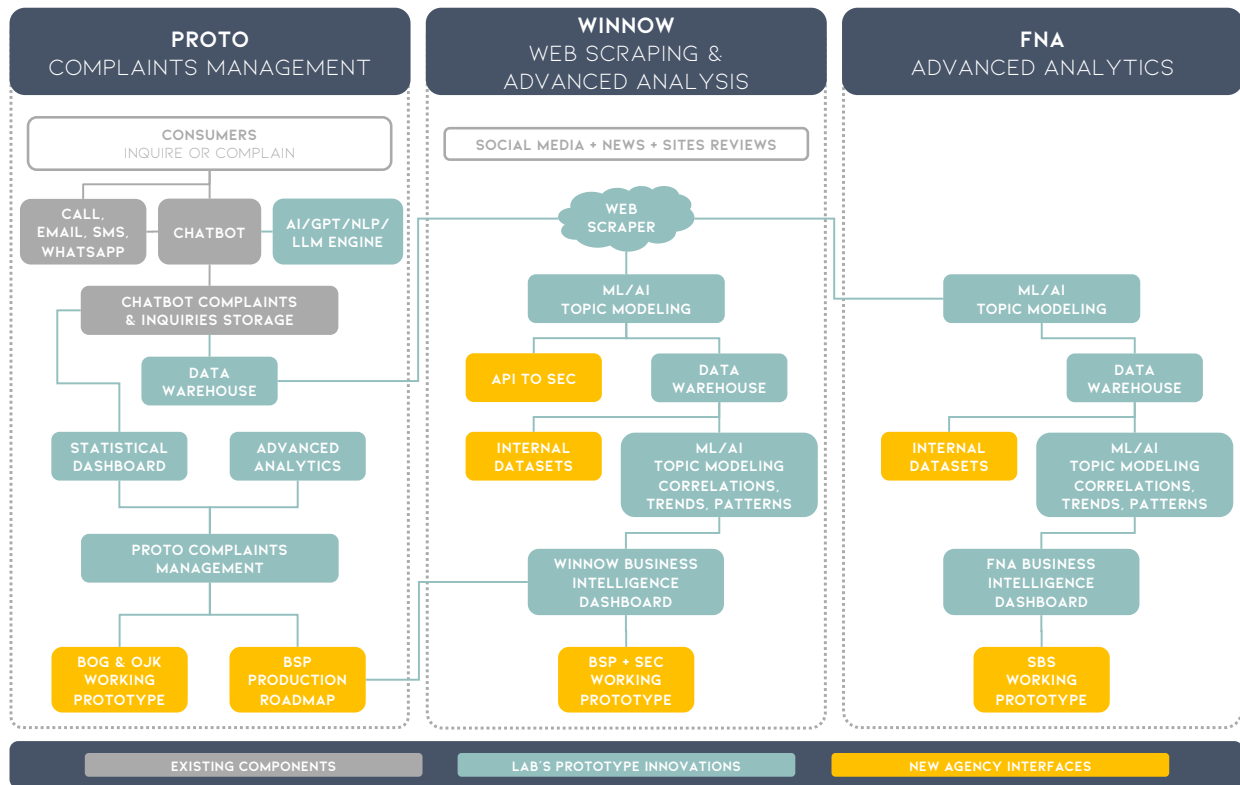


FIGURE 80.

CAMBRIDGE SUPTECH LAB LAUNCHPAD 2023 WORKING PROTOTYPES



These prototypes mark a significant advancement in suptech applications, introducing sophisticated capabilities to existing chatbot and complaint management platforms. They leverage tools for web and social media scraping and integrate with other supervisory initiatives, employing machine-learning techniques for advanced topic modelling. These methodologies are adept at identifying correlations, detecting patterns and trends that could indicate potential misconduct or fraud.

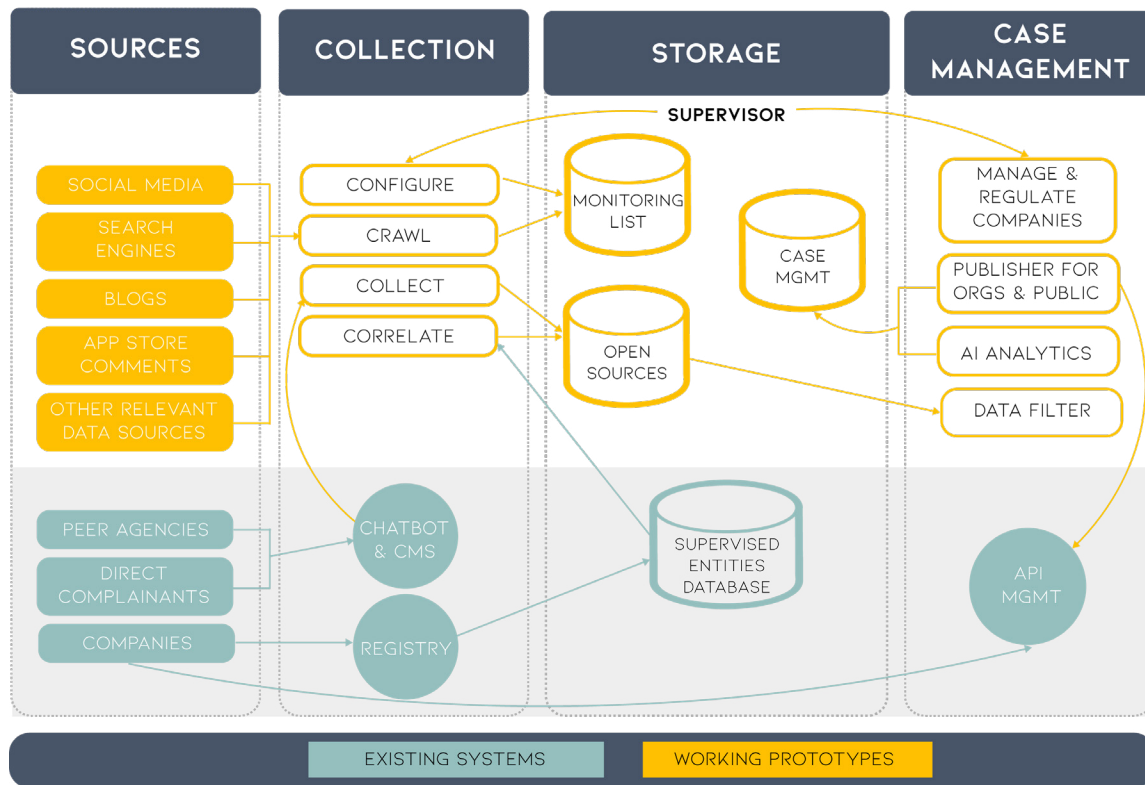
A critical aspect of the initial configuration of these tools was the agencies' provision of targeted lists of entities and keywords/phrases. This focus enabled the systems to effectively analyse public sentiment across various products, channels, and regulated entities. The primary objective was to discern emerging trends and patterns indicative of potential

misconduct, with the aim of preemptively identifying anomalies before they escalate into widespread consumer issues. This proactive approach exemplifies the evolving nature of financial supervision, where technology is leveraged not only for monitoring but also for predicting and preventing financial irregularities.

Social media monitoring, which involves web scraping and sentiment analysis, enables market conduct supervisors to gather real-time data on consumer issues. For example, it can quickly identify complaints about services like online banking unavailability or long customer wait times. This data feeds into market conduct risk assessments, policy development, and supervision of individual financial service providers. In one case, social media monitoring helped uncover an unauthorised firm in Ireland, leading to its immediate cessation of

FIGURE 81.

SCHEMATIC FOR THE FINANCIAL CONSUMER PROTECTION SUITE WITH WEB SCRAPER AND ML-BASED ANALYSIS



operations after a [warning notice](#) was published by the Central Bank of Ireland.

Web scraping and sentiment analysis are increasingly applied in several areas of financial supervision for various purposes, including financial stability and ESG supervision. For instance, the Bank of Italy [uses social media](#) to assess customer sentiment towards companies and its impact on stock returns, trading volumes, and even to investigate payment card scams. OECD as part of a [contribution from The Spanish National Commission for Markets](#) that pointed out that web techniques such as web scraping or text mining can be used to increase data availability for case detection in cartel investigations. In the realms of insurance and prudential supervision, the [BIS reported](#) that the use of these tools can be useful to analyse narrative reports from insurers to identify potential prudential issues or to comb through social media posts for possible conduct-related issues.

In addition, in the area of ESG reporting, the UK Office for National Statistics (ONS) has used web scraping and natural language processing to measure sustainability reporting, and has [published code](#) on github as an open resource.

4.1.1. Financial consumer protection suite with web scraper and machine learning-based analysis for Philippines Central Bank (BSP) and Securities and Exchange Commission (SEC) Philippines

For the prototype developed with the BSP and SEC Philippines, [Winnow Technologies](#). (Winnow) provided an automated platform to ingest, process, analyse, and visualise streams of data from social media channels, app-store reviews, and news sites, along with APIs for integration with existing complaints management systems.

Winnow's advanced technology harmonises public datasets with internal agency data, applying sophisticated sentiment analysis, topic modeling, and other machine learning techniques. This integration significantly enhances the monitoring capabilities of financial authorities by enabling them to process and analyse large volumes of data effectively.

The implementation of this technology is pivotal for supervisors, offering them insights into public discussions and perceptions about the services, goods, and support provided by regulated entities. These discussions often take place on social media platforms and in online reviews, where customers frequently voice their experiences and opinions. This tendency arises from a [general reluctance to lodge formal complaints](#), leading customers to express their concerns on more familiar and accessible communication channels.

By tapping into these sources of informal feedback, supervisors gain a more immediate and candid view of customer sentiments. This approach allows for a proactive stance in identifying and addressing potential issues with financial products and services. Instead of relying solely on formal complaint channels, which may only capture feedback after an issue has escalated, the use of Winnow's technology enables authorities to detect early warning signs and trends. As a result, they can act swiftly to address emerging problems, enhancing consumer protection and maintaining the integrity of the financial system.

Once the data is meticulously gathered, correlated, and categorised, proprietary AI methodologies are employed to infer sentiment and topics. This data is then systematically organized in a centralised database system, ensuring secure and efficient storage. The data is then made available via the two channels described

below, each with unique benefits: via API for integration into on-premises systems and processes, as well as via visualisations in a dashboard.

For the SEC Philippines, the API approach was more attractive. The integration of the processed public data into their proprietary systems allowed them to continue their own proprietary algorithms for correlations and other AI analytics, while benefiting from those additional insights provided by the vendor.

The BSP, who already works with complaints dashboards, prefers to facilitate via the vendor's custom-designed dashboards. These interfaces feature user-friendly access and analysis, display the data, offering intuitive navigation and visualisation. They are equipped with diverse filtering capabilities (such as time, entities, product, topic, etc.), allowing users to sift through the data using eleven different methods. For instance, users can opt to view only entries with low sentiment scores, sort data by date, or focus on specific products, among other options.

This granularity enables supervisors to hone in on particular areas of interest or concern. The filters can be applied to both the visualised data and the underlying raw data, which is meticulously stripped of any personally identifiable information and other sensitive data to ensure compliance with privacy regulation.

The platform also offers the functionality of side-by-side comparison between different filtered datasets. This feature is invaluable for supervisors, allowing them to benchmark one supervised entity against others within the same market segment or to compare one market segment with another. Such comparisons are particularly useful for detecting anomalies. For instance, they can identify if a bank is an outlier compared to its competitors, or if a larger segment of the

market is disproportionately affected by a significant event, signaling a need for additional investigation and oversight.

Furthermore, the system's design allows for the customisation of queries. Users can save their preferred filters and settings for future reference, streamlining the process of data retrieval and analysis. The system also includes an alert feature, which can be configured to notify users of specific patterns or thresholds being met. This functionality enhances the proactive monitoring capabilities of financial supervisors, enabling them to respond swiftly and effectively to emerging trends or issues within the financial landscape.

Regarding the real-time aspect of this system, the envisioned production configuration would enable supervisors to collect and analyse social media data, app store reviews, websites, and locally-sourced data such as complaints and interactions from the supervisor's own forms and chatbots, all in real-time. This would ensure that users have a constantly updated visualisation of their supervisory landscape.

To accommodate various operational and regulatory requirements, the system offers flexibility in deployment. It can be set up on-premises in a co-located server, within a secure cloud environment, or in a hybrid configuration. This adaptability ensures that the system can align with legal constraints, data security standards, and the specific needs of the supervisory authority.

Winnow's platform offers an advanced level of automation that adeptly adjusts to the dynamic nature of web platforms. This adaptability is crucial, as it alleviates the burden on supervisors of constantly maintaining and updating data collection mechanisms. Instead, supervisors can concentrate on their primary responsibility: effective financial oversight. This automation not only ensures that the

system remains current with the latest changes and trends in web and social media platforms, but it also enhances the efficiency and accuracy of data collection. By automatically adjusting to new formats, terminologies, and data sources, the platform ensures a continuous and uninterrupted flow of relevant and up-to-date information.

This feature is particularly valuable in the fast-paced digital world where financial products and services, as well as consumer behaviors and sentiments, are constantly evolving. With this automated adaptability, supervisors are better equipped to focus on interpreting the data and applying their expert judgement in financial supervision, rather than being bogged down by the technicalities of data collection and system maintenance.

FIGURE 82.
WINNOW PROTOTYPE ARCHITECTURE DIAGRAM

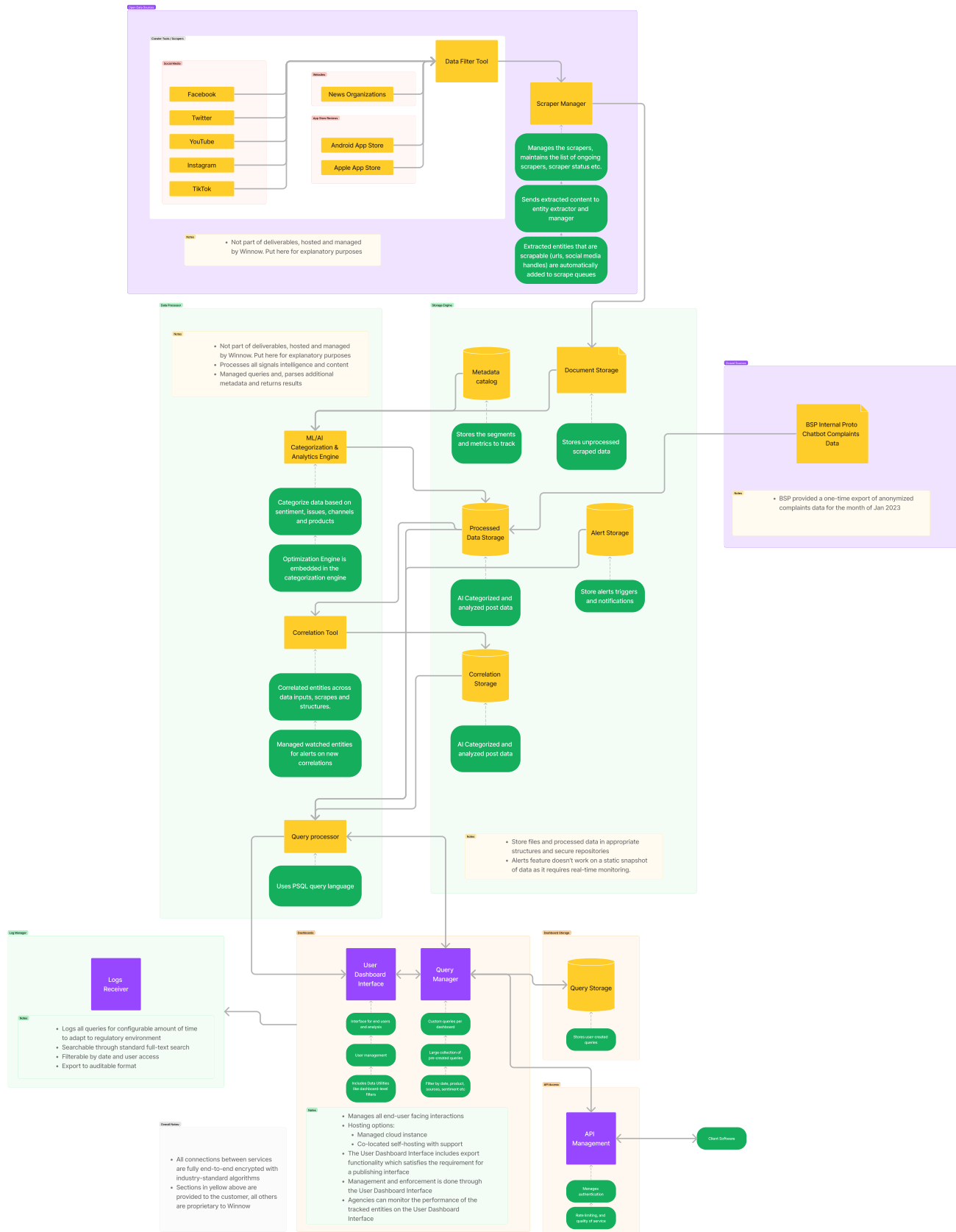


FIGURE 83.

WINNOW'S PROTOTYPE FINANCIAL CONSUMER PROTECTION AND MARKET CONDUCT SUPERVISION DASHBOARD



4.1.2. Next-generation AI-powered chatbot supported complaints management system for Bank of Ghana (BOG) and the Indonesian Financial Services Authority (OJK)

For the prototype developed in partnership with the BOG and OJK, [Proto](#) adapted their AICX platform, a comprehensive suite of solutions designed for supervisors to collect, triage, and categorise complaints collected through advanced AI-enabled multilingual chatbots and other channels selected for maximal accessibility. Through a partnership with Winnow Technologies Inc. (see 4.1.1), they also integrated social media and web monitoring to complement their traditional complaints systems.

Beyond their existing management features, the platform also includes native reports for analysing the resulting data. Furthermore the prototype tested the extension of the platform to allow for

modular integration of internal legacy data via APIs, as well as embedded third party visualisations from other supervisory platforms, allowing for composition of supotech solutions and constituting a move toward a more comprehensive, single supervisory dashboard.

As elaborated in section 3.5 of this Report, the vendor has iterated its design over the last several years with input from financial authorities around the world. As such, the deployment of this solution could be significantly faster than developing a complaints system from scratch. Additionally, the vendor is continuing to innovate new features using cutting-edge technology, so agencies benefit as new features are deployed and the platform is upgraded.

These can easily be configured by the agency, with support and training videos and instructions that cover how to create,

FIGURE 84.
SCHEMATIC DIAGRAM FOR THE NEXT-GENERATION, AI-POWERED, CHATBOT SUPPORTED COMPLAINTS MANAGEMENT SYSTEM

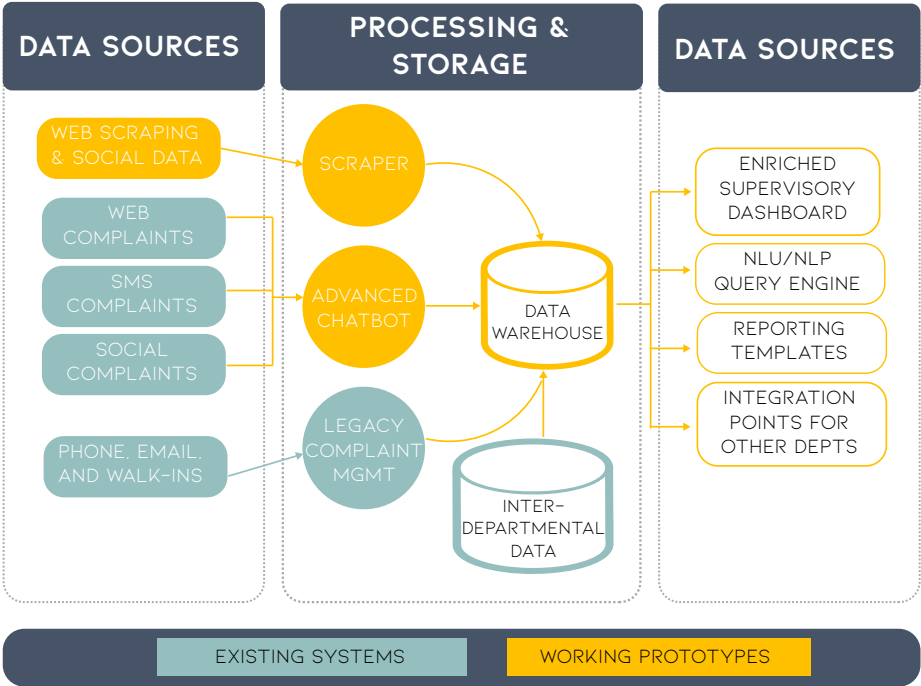


FIGURE 85.
PROTO'S PROTOTYPE ARCHITECTURE DIAGRAM

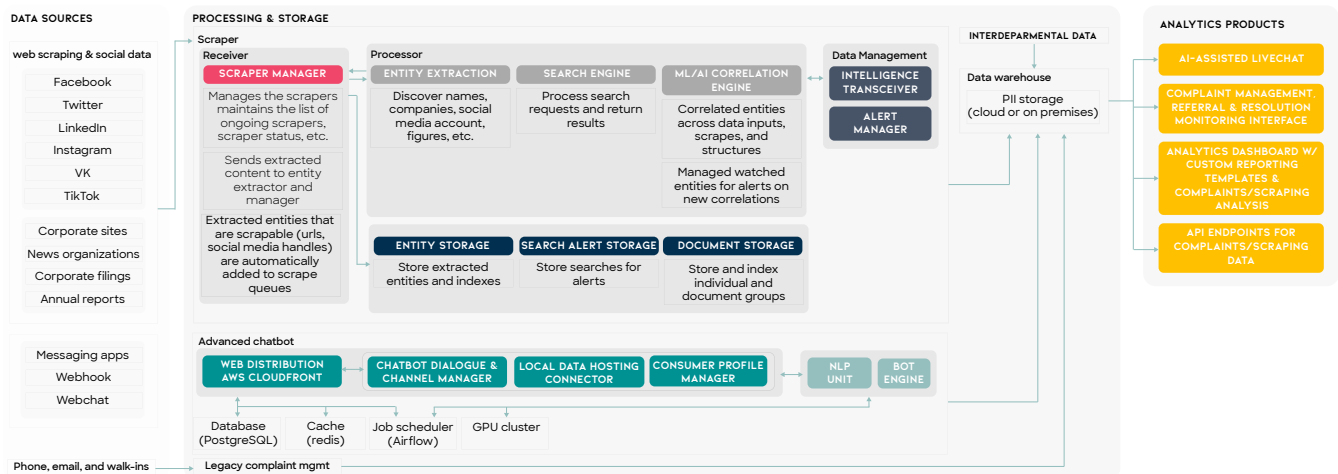
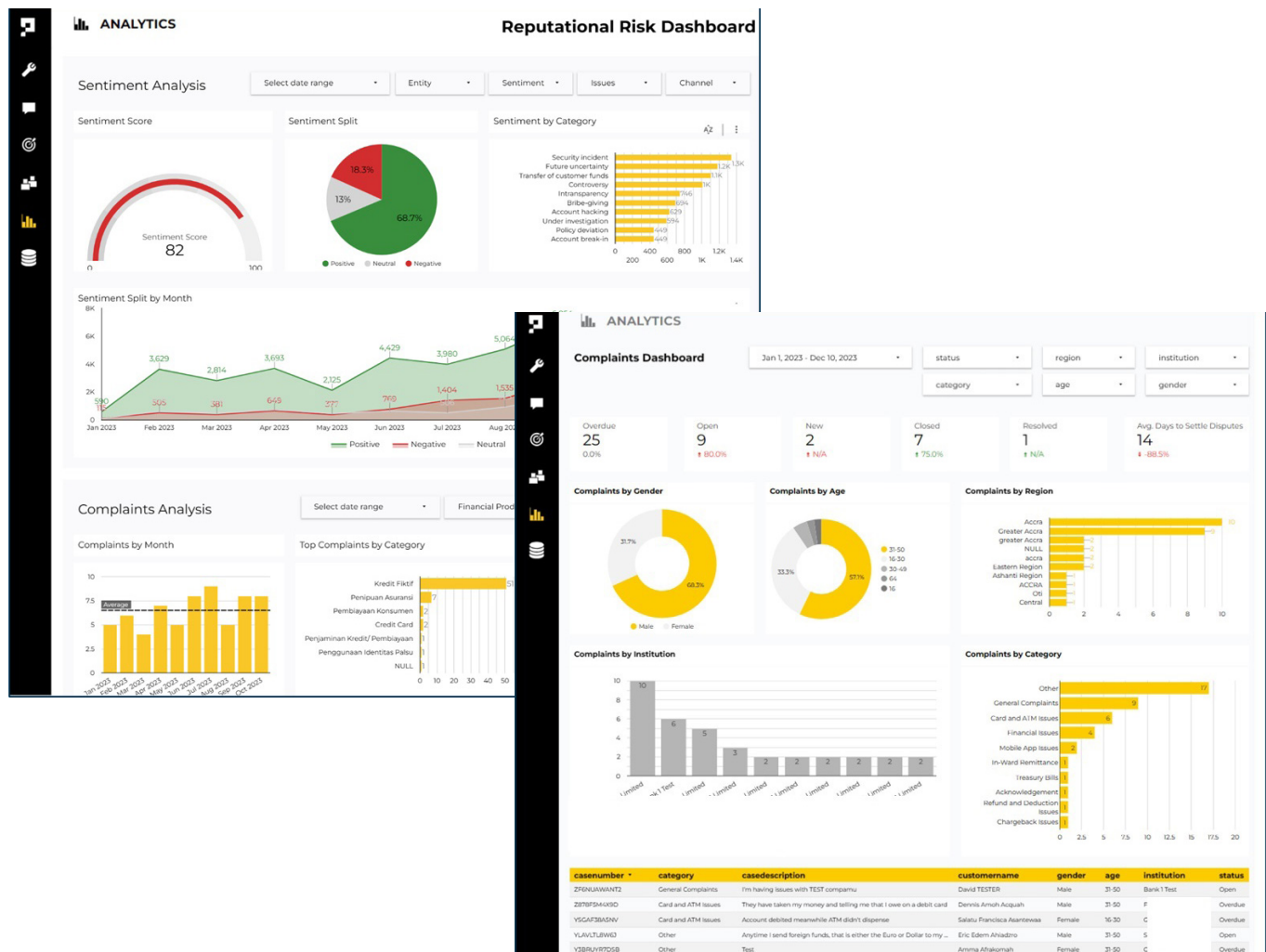


FIGURE 86.
SCHEMATIC DIAGRAM FOR THE NEXT-GENERATION, AI-POWERED, CHATBOT SUPPORTED COMPLAINTS MANAGEMENT SYSTEM



edit and deploy multi-lingual chatbots, view and manage complaints, respondents, the advanced analytics dashboard and more. This dashboard focuses on scraped sentiment from financial service providers' social media pages and complaints data. It provides a sentiment score that can be generated based on any filters applied to the report. Examples of use cases include:

1. Sentiment score for a given supervised entity compared to its fraud trend: Filter a given supervised entity only and choose the period, the dashboard will show the sentiment score and fraud trend for the given supervised entity.
2. Sentiment score for a given supervised entity versus all others in the country: Open two views of the dashboard, select all banks in one view and a given supervised entity in the other and compare side by side.

Per the financial authorities' requirements, the sentiment score is calculated by assigning a score of 1 to 5 to each comment received by financial institutions, with 1 being the most negative and 5 being the most positive. The calculation involves summing up these individual scores for all comments and then expressing it as a percentage.

The working prototype developed by Proto augments existing chatbot deployments. Recent upgrades to the platform bring Natural Language Processing (NLP) and other AI technologies into the collection process. The chatbot can be configured by the agencies' users to provide AI-generated conversational responses to inquiries using content found in agencies specified sources, such as their website, a regulations database, or other trusted approved sources. Once a consumer submits an inquiry or complaint through the chatbot, the data collected can be stored in the platform's databases to

be processed by the integrated case management module, or it can be sent to a separate case management system via API. The working prototype also developed a new analytics module which ingests, pre-processes and presents the data scraped from public sites, along with consumer complaints statistical analysis in an interactive dashboard designed with both BOG's and OJK's input.

The advantages of using an advanced chatbot and integrated case management and analytical platform for consumer complaints, coupled with the ability through partnerships with Winnow Technologies Inc. to correlate this with online data, include the ability for financial authorities to:

- [Democratise financial consumer protection](#) making available to users a new channel accessible through any mobile device.
- Leverage artificial intelligence techniques such as natural language processing and Generative AI to facilitate automated resolution of consumer inquiries in various languages and from various aptitude levels.
- Increase in consumer literacy as users can more easily access information on financial services/products pushed by the authorities, thus make faster and well-informed decision on products/services offered by financial institutions.
- Filter the number of inquiries and complaint tickets that the supervisors need to manage.
- Reduce the time to process and resolve the complaints.
- Increase in customers satisfaction on the complaint-handling mechanism, easily accessible status updates,

improved resolution, fast turn-around time. In turn, this increases user's trust in the formal financial sector.

- Integrate market conduct perspective in the prudential supervision framework.
- Leverage the data collected from the user to ensure the complaint is solved, extract insights to assess financial service providers' compliance with market conduct regulation, and to enhance financial inclusion policies and market conduct regulation.
- Reduce cost and time spent on handling customers' queries and complaints.
- Handle large volume of queries and complaints simultaneously.
- Automate data processing enabling easy tracking of complaints and improve resolution and customer experience with limited supervisory resources.

4.1.3 Financial market monitoring via social media and web extraction for the Superintendence of Banking, Insurance and Private Pension Funds Administrators of Peru (SBS)

The advanced analytics company [FNA](#) collaborated with the SBS Peru on a working prototype with an emphasis on advanced monitoring tools via social media and other channels, building on initial efforts already in place at the agency while also experimenting with alternatives such as Winnow Technologies' platform.

These advanced social media market monitoring tools extend the existing capability and innovation of the authority, enhancing its supervisory model by going beyond basic sentiment analysis to surface trends, anomalies and other patterns in the data that is relevant to monitoring of entities and activities flagged through other processes.

The focus of the project was to use NLP methods for sentiment analysis, keyword

FIGURE 87.

SCHEMATIC DIAGRAM FOR THE PLATFORM FOR FINANCIAL MARKET MONITORING VIA SOCIAL MEDIA AND WEB EXTRACTION

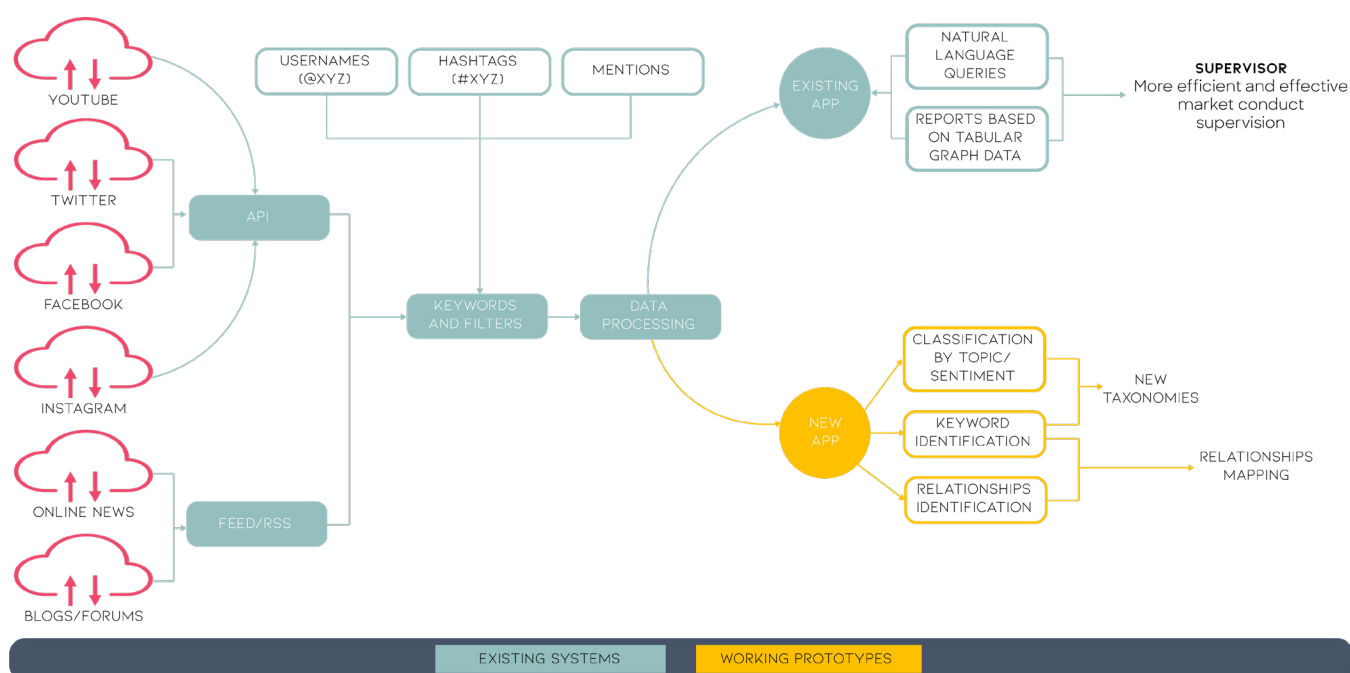
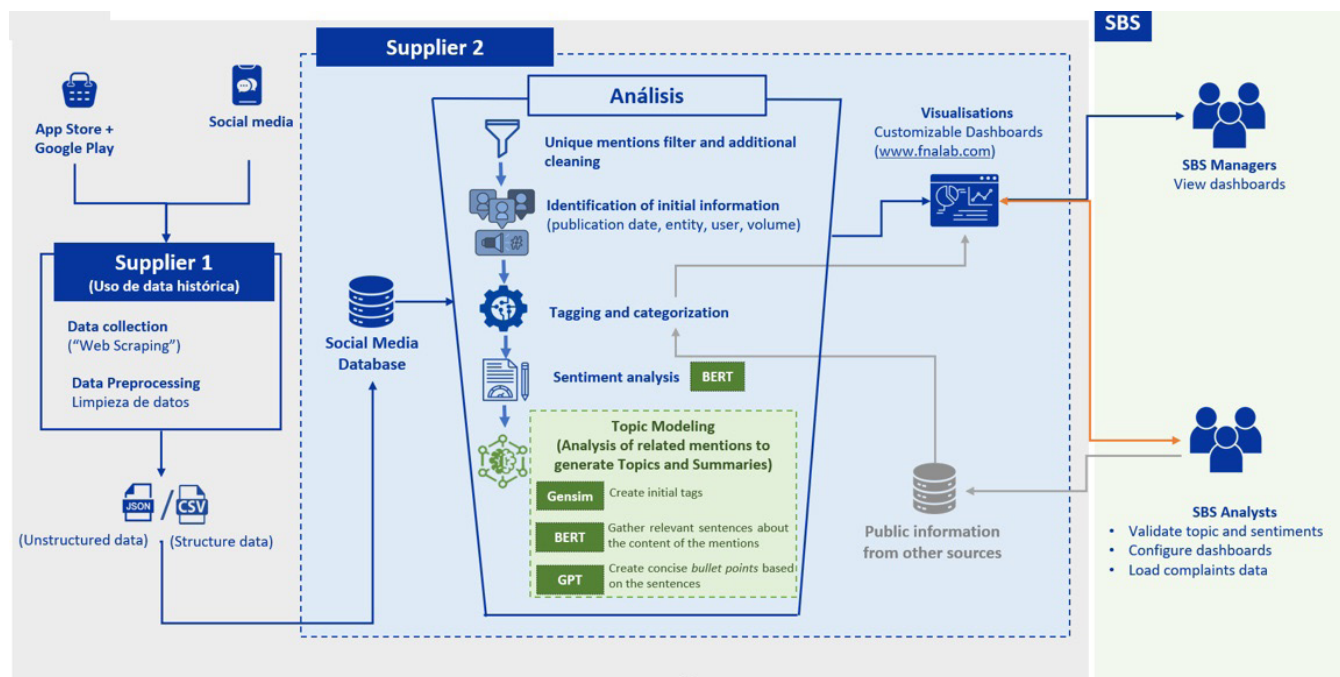


FIGURE 88.
SBS/FNA ARCHITECTURE DIAGRAM



tagging and topic modelling of social media posts. FNA found that a mix of BERT, Gensim and GPT provided the most useful outcome for SBS. Results are presented in a cloud-based graph database with filtering and visualisation capabilities, including interactive timelines, treemaps, bar charts and tables.

The prototype primarily focused on leveraging the legacy social media monitoring system along with Winnow's modern web monitors to surface three forms of advanced analytics.

- 1. Sentiment analysis.** Using a BERT-based, multilingual model fine-tuned on around 50,000 data points for sentiment analysis in Spanish, each post is assigned a sentiment based on its contents: ('Negativo', 'Neutral', 'Positivo')
- 2. Topic classification.** After using natural language toolkit (NLTK) and regular expressions to clean the data, supervised machine learning models assign a set of tags (e.g., 'Credito',

'Cuentas', 'Comisiones', 'Prestamos') based on keywords mentioned in the contents, as well as a category (e.g., banking services, channels and other).

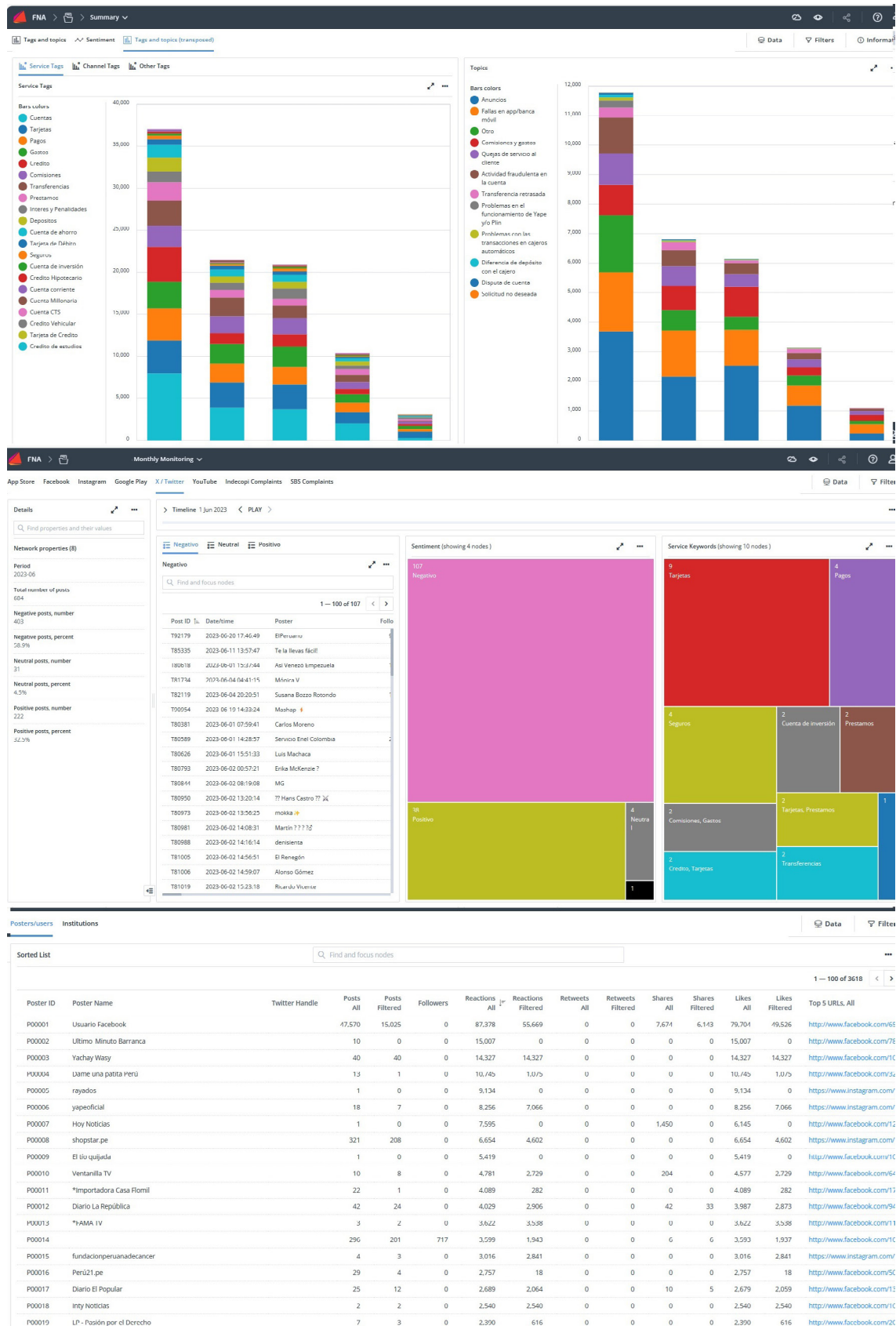
- 3. Advanced detailed topic extraction.** Using unsupervised machine learning models (e.g., LDA), additional detailed topics (e.g., 'Imposibilidad de efectuar pagos', 'Gastos y comisiones') are extracted from the overall corpus. For each detailed topic, reviewers name the topic based on a summary of the posts within that topic produced by BERT Extractive Summarizer and GPT.

Once fully deployed, the solution would allow supervisors to:

- Unlock better Market Conduct risk management: social media monitoring provides real-time information about market conditions and emerging consumer risks, allowing the agency to make informed decisions and manage risk effectively.

FIGURE 89.

SCREENSHOTS OF FNA'S ADVANCED SOCIAL MEDIA ANALYTICS PLATFORM, POWERED BY LEGACY COLLECTION SYSTEMS AND WINNOW



- Bridge the gap between reactive response and preventive action with proactive monitoring to ensure potential risks are identified, analysed, and acted upon before they escalate.
- Constant real-time updates about the general population's sentiment, specific products, issues or entities enables financial leaders to predict potential misconduct and timely intervene (e.g., through on-site examinations) when risks are greater or more imminent.
- Enjoy a continuous influx of data that provides early warning signals of potential financial misbehaviour and reputational harm.

4.2. Prudential supervision of banks and non-bank deposit taking institutions: Athena transforming European Central Bank (ECB)'s supervisory capabilities with AI

Supervisors evaluate extensive amounts of unstructured data in diverse formats within tight timeframes for their assessments. Diligence is crucial to prevent any oversights, yet this proves to be a highly resource-intensive undertaking. Supervisors at the ECB analyse a broad range of relevant documents including news articles, supervisory assessments, and banks' own documents. These documents are usually scanned or includes images, making difficult to import into NLP tools. Moreover, the submitted documents are usually not in English, due to the Single Supervisory Mechanism (SSM) nature, pressing the need for translation services.

But more importantly, supervisors at the SSM need structured insights and robust foundation for initiating the analysis for significant institutions; a tool to enhance their capacity to juxtapose internal assessments, establishing connections between diverse dimensions and data sources, thereby enhancing both internal and external perspectives.

The ECB [has been working](#) with national competent authorities (NCAs) in suptech tools since 2020, but was in 2021 when the institution assessed, prioritised and started to implement suptech as part of the SSM Digitalisation Blueprint. At the moment, there are already more than a dozen of these in use, enhancing the daily operations of supervisors and facilitating the smooth integration of European

banking supervision.

The vision of the institution is to deliver “supotech at your fingertips,” enabling supervisors to obtain a real-time overview of the banks they oversee with just a few clicks. This approach combines the strengths of technology, data, and innovation. These three elements are intricately connected and will serve as the fundamental pillars of the new “[SSM Digital Strategy 2024-2028](#).”

In 2021, the ECB rolled out [Athena](#), the first SSM-wide tool for textual analysis. Athena advances the analysis of documents and unstructured data via AI-driven textual analysis. The platform uses natural language processing technology to speed up textual analysis – to front-line supervisors across the SSM. News articles, supervisory assessments and bank documents are fed into Athena, which allows users to find, extract and compare information in a single user-friendly web-based platform. Supervisors working on-site inspections have access to an English-language, machine-readable version of credit files that come in native EU languages. With Athena, SSM and

NCA supervisors can now analyse and compare information from a vast data lake, transforming the way they approach their crucial tasks.

The NLP models are trained with the most relevant data sources for supervision including narratives and scores from the Supervisory Review and Evaluation Process, DARWIN (ECB’s IT tool for the management of documents and records) and databases comprising news articles in the domains of finance, banking, and international economics. Integrating this information, Athena supports supervisors with topic classification, sentiment analysis, dynamic topic modelling and entity recognition.

The [machine learning models](#) are trained to assess document types, classify data on a hierarchy of topics, determine trending topics, perform sentiment analysis and identify references to supervised institutions via entity recognition. Supervisors can now collate these kinds of enriched texts within seconds, so they can more quickly understand the relevant information – instead of spending time searching for it.

FIGURE 90.
ATHENA FUNCTIONALITIES



Source: [European Central Bank 2023](#)

Utilising a sophisticated search engine, state-of-the-art natural language processing techniques, automated optical character recognition, and translation capabilities, Athena substantially reduces the need for manual intervention in supervisory assessments.

Athena is helping to address supervisory and regulatory blind spots.

- The AI technology allows officials performing horizontal analysis to efficiently check for compliance and consistency of regulatory standards, guidance, and methodologies.
- When setting supervisory priorities, Athena allows officials to identify trends in the market and emergent risks. Therefore, it allows officials to spot and assess new risks at the banking sector level and at an individual bank level using machine learning models.

Some important lessons have been extracted from the Athena project:

- **Keeping the human in the loop when it comes to AI is vital.** Though the machine learning models make suggestions and predictions, the suptech team at the ECB recognise the value of expert judgement, which will continue to play an essential role in supervision.
- **Collaborations are important.** The ECB is exchanging knowledge on the development and use of AI models with NCA and other institutions outside the EU. Beyond the SSM, they constantly [exchange](#) on developments in the field of NLP with peers, such as the Bank of England, the United States Federal Reserve Board and the Central Bank of Brazil. They are trying to align on the latest best practices and see how well they can collaborate further in this field.
- **AI and the risks it entails.** The ECB is

cognisant of the risks that come with AI and are looking at key questions in the fields of data privacy, legal constraints, and ethical considerations (such as fairness, transparency, and accountability).

Looking into the future, the ECB seeks to introduce a note-taking functionality to Athena which will enable supervisors to annotate analysed content. Sharing these will improve transparency in the decision-making process as it becomes more auditable and consistent. The high-quality input data can also be used to advance AI functionalities.

Athena 2.0 will harness advancements in large language models (LLM) to enhance existing functionalities and create new NLP capabilities including: summarisation, Q&A/chat feature and vector search.

4.3. AML/CFT/CPF supervision: The Hong Kong Monetary Authority (HKMA) network analytics

In response to the increasing threat of financial crimes in the era of instant payment systems, The HKMA has implemented a network analytics solution.

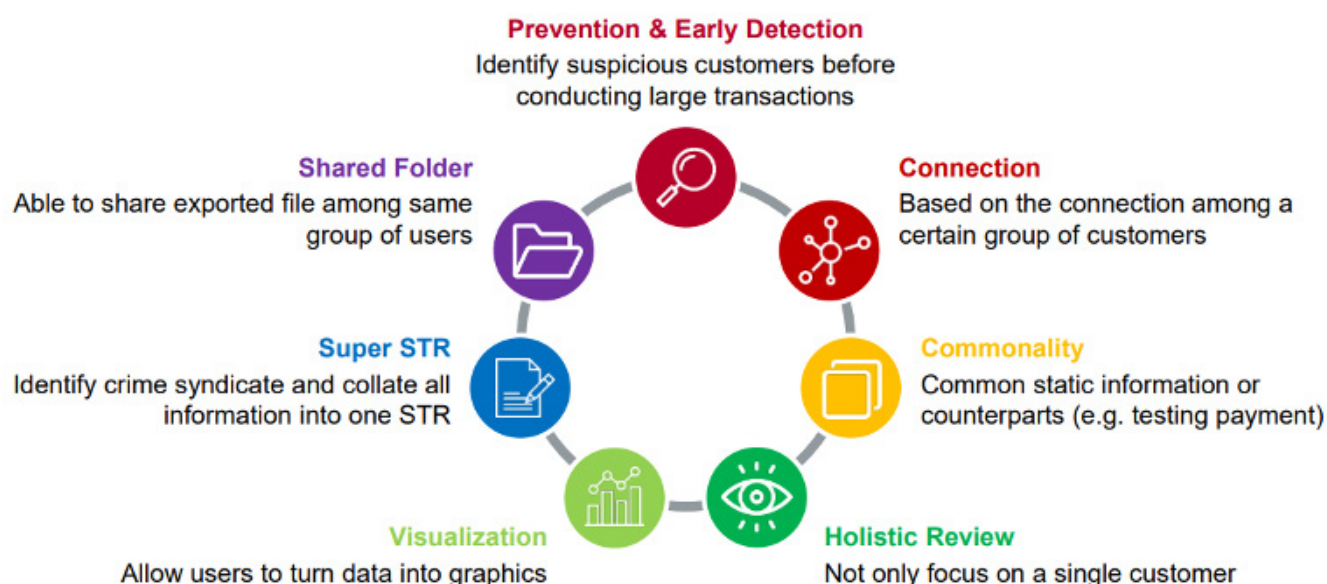
The introduction of instant payment systems around the world has [accelerated](#) in recent years. There are now over 80 instant payment systems globally, with more than 35 being launched in the last five years and eight currently being built. The number of instant payments is estimated to surge from 195 billion in 2022 to 511 billion by 2027, representing a compound annual growth rate of 21.3%. These systems bring unprecedented speed and efficiency to payments markets, with greater convenience for consumers. However, faster payments also mean faster financial crime i.e.,

fraud and anti-money laundering.

In Hong Kong, the volume of fraud cases more than doubled in the four years following the introduction of the Faster Payment Service in 2018, operated by Hong Kong Interbank Clearing Limited (HKICL). As of August 2022, the number of FPS users (both consumers and merchants) was 10.9 million with more than 900,000 average daily payment numbers. As of 2022, 27,923 deception cases were recorded by the Hong Kong Police Force (HKPF) – a 45% increase over the same period the previous year – [resulting](#) in monetary losses of at least HK\$ 4.8 billion.

Fraudsters use complex and sophisticated transaction schemes that span across banks to conceal the destination of fraudulently acquired funds. This means that no bank has full visibility of this network with their own payments data alone. It also means that standard rules and statistical approaches to fraud detection and prevention based on siloed bank-level data are limited in their effectiveness

FIGURE 91.
NETWORK ANALYTICS CAPABILITIES



Source: [HKMA, 2021](#)

as they fail to fully capture the network dimension. Much of the illicit activity in Hong Kong will have been conducted or enabled via networks of mule accounts – a significant threat highlighted in the [Money Laundering and Terrorist Financing Risk Assessment Report](#).

Taking a centralised data approach and deploying technology that takes advantage of this centralised data is critical to robust national anti-fraud capabilities as [indicated](#) by FNA. Mule account activity, by its very nature, involves networks of interconnected accounts characterised by short periods of high activity. In order to effectively detect and disrupt this, the ability to analyse relationships and behavioural patterns – network analytics – is crucial.

A key benefit of network analytics lies in its ability to provide investigators with much richer context as they can fuse internal and external data points to develop a series of dynamic risk indicators.

As part of its collaboration with industry (e.g., banks) and law enforcement (e.g., Hong Kong Police Force), HKMA has started a pilot using network analytics to detect mule account networks and help disrupt movements of fraud proceeds. The HKMA system is designed to analyse transactional data, user behaviour, and network patterns in real-time. Leveraging advanced analytics and machine learning algorithms, the system identifies anomalies, suspicious patterns, and potential threats within the vast network of instant payment transactions.

The solution features:

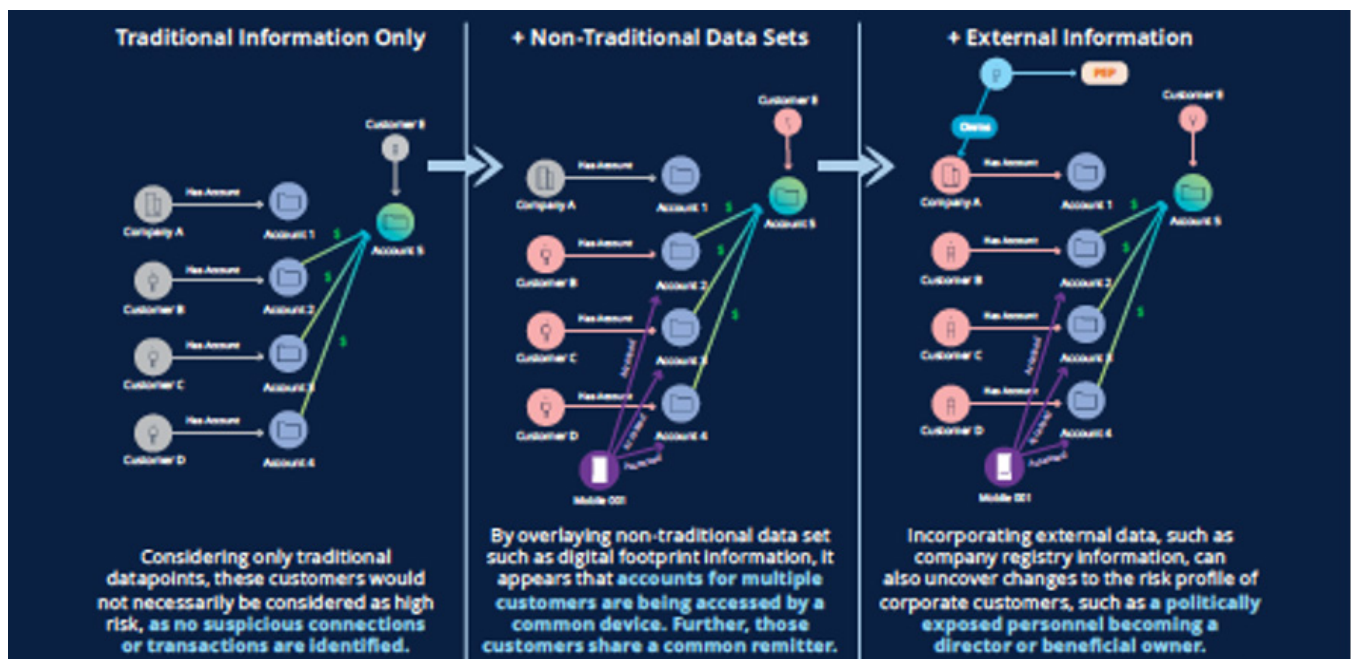
Real-time transaction monitoring

- Continuous analysis of instant payment transactions as they occur in real-time.
- Immediate detection of unusual patterns or deviations from normal behaviour.

User behaviour analytics

- Profiling user behaviour based on historical data.

FIGURE 92.
OVERLAYING EXTERNAL INFORMATION TO ENRICH NETWORK ANALYTICS



Source: [HKMA](#)

- Identification of deviations from established patterns, flagging potentially fraudulent activities.

Network pattern recognition

- Analysis of transaction networks to identify hidden relationships and connections.
- Detection of complex money laundering or fraud schemes involving multiple actors.

Machine Learning algorithms

- Implementation of advanced machine learning models for predictive analytics.
- Continuous learning and adaptation to evolving financial crime tactics.

Integration with other frameworks

- Facilitation of information sharing with financial authorities to enhance overall financial security.

The implementation process encompassed four primary dimensions:

1. Data collection

- Aggregation of transactional data from instant payment systems, including user profiles, transaction amounts, and timestamps.

2. Pre-processing and enrichment

- Cleaning and standardising data to eliminate inconsistencies.
- Enrichment with external data sources for enhanced context and accuracy.

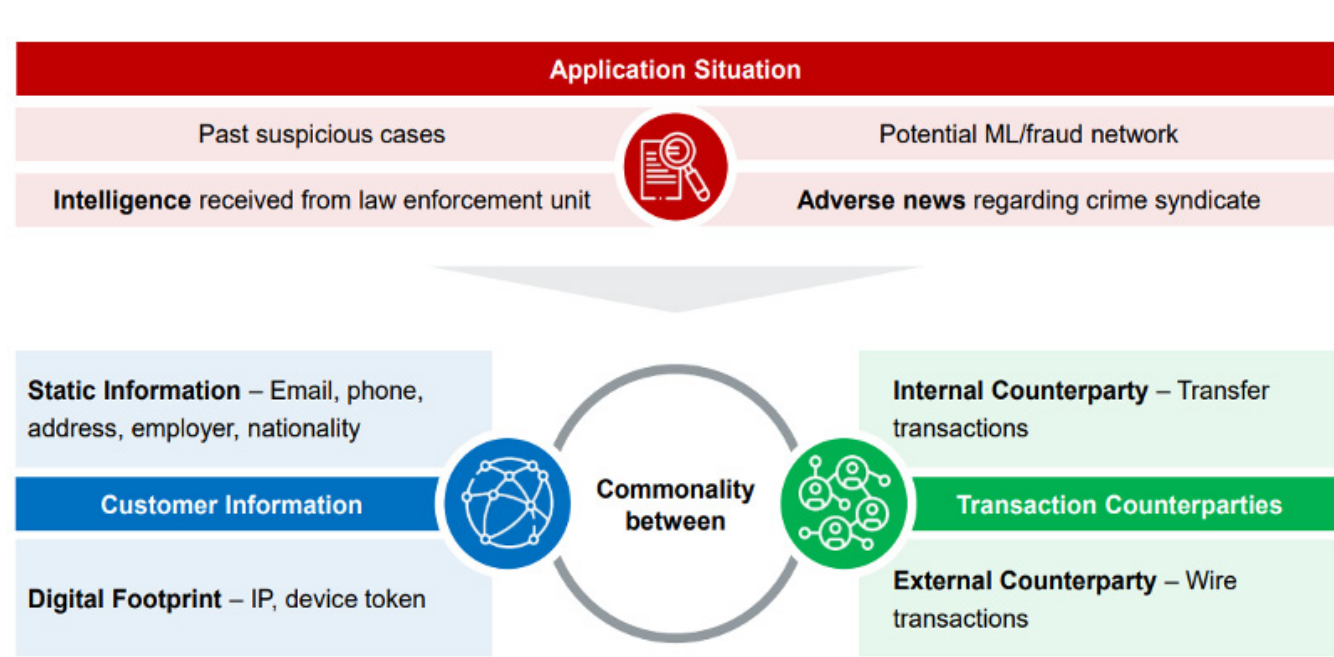
3. Algorithmic analysis

- Application of machine learning algorithms to identify normal behaviour and outliers.
- Calibration of the system to minimise false positives and negatives.

4. Alert generation

- Automated alerts triggered for potentially suspicious activities.
- Prioritisation of alerts based on risk scores and severity.

FIGURE 93.
NETWORK ANALYSIS APPLICATION



Source: [HKMA, 2021](#)

The implementation of the AML/CFT/CPF by HKMA has led to remarkable outcomes:

Enhanced detection capability

- Significantly improved detection of suspicious transactions and potential financial crimes.
- Early identification of emerging threats, contributing to a more proactive response

Reduction in false positives

- Fine-tuning of algorithms has minimised false positives, allowing investigators to focus on genuine threats.
- Resource optimisation and improved efficiency in investigating flagged transactions.

Adaptive response to evolving threats

- Continuous learning mechanisms enable the system to adapt to new and sophisticated financial crime tactics
- Increased resilience against emerging threats in the rapidly evolving financial landscape.

The AML/CFT/CPF supervision project of the HKMA underscores the pivotal role of collaboration in leveraging network analytics. The project encourages active collaboration between banks and the fintech community, along with law enforcement agencies, to use data and technology more effectively.

The project's experience also reveals several success factors for adopting suptech within an organisation. One key strategy is to start small, allowing for easier demonstration of value and stakeholder buy-in. The involvement of external experts and vendors can offer valuable resources and insights. Setting clear, tangible success criteria helps communicate the benefits to key stakeholders and ensures that new solutions offer additional value, like deeper insights.

Success also hinges on multi-disciplinary collaboration, involving supervisors, data scientists, and technology specialists, rather than relying solely on individual experts. Importantly, initiating network analytics does not require perfect data conditions but can start with the available data, highlighting the importance of beginning such endeavors without delay.

4.4. Payments oversight: Payments Canada digital twin for intraday liquidity simulated scenarios

Payments Canada, responsible for operating national payment systems in Canada, [partnered](#) with FNA to design and build a digital twin of Lynx, their real-time gross settlement (RTGS) system. The aim was to understand the impacts of various configurations and participant behaviours on intraday liquidity through simulated scenarios prior to Lynx's implementation.

Payment and settlement systems require constant modification and modernisation. Implementing these changes is often extremely costly due to the known and unknown complexities of the multiple, tangled agents, systems and behaviours involved. The only way to understand the true complexity is to construct a digital twin of the payment ecosystem and learn through simulation.

The challenge faced by Payments Canada was the potential increase in liquidity needs compared to the previous system, large value transfer system (LVTS), which was considered very efficient in terms of liquidity. There were also concerns about how participant behaviour might change with the new system and the implications for intraday liquidity risk.

To address these challenges, Payments Canada engaged FNA to create a digital

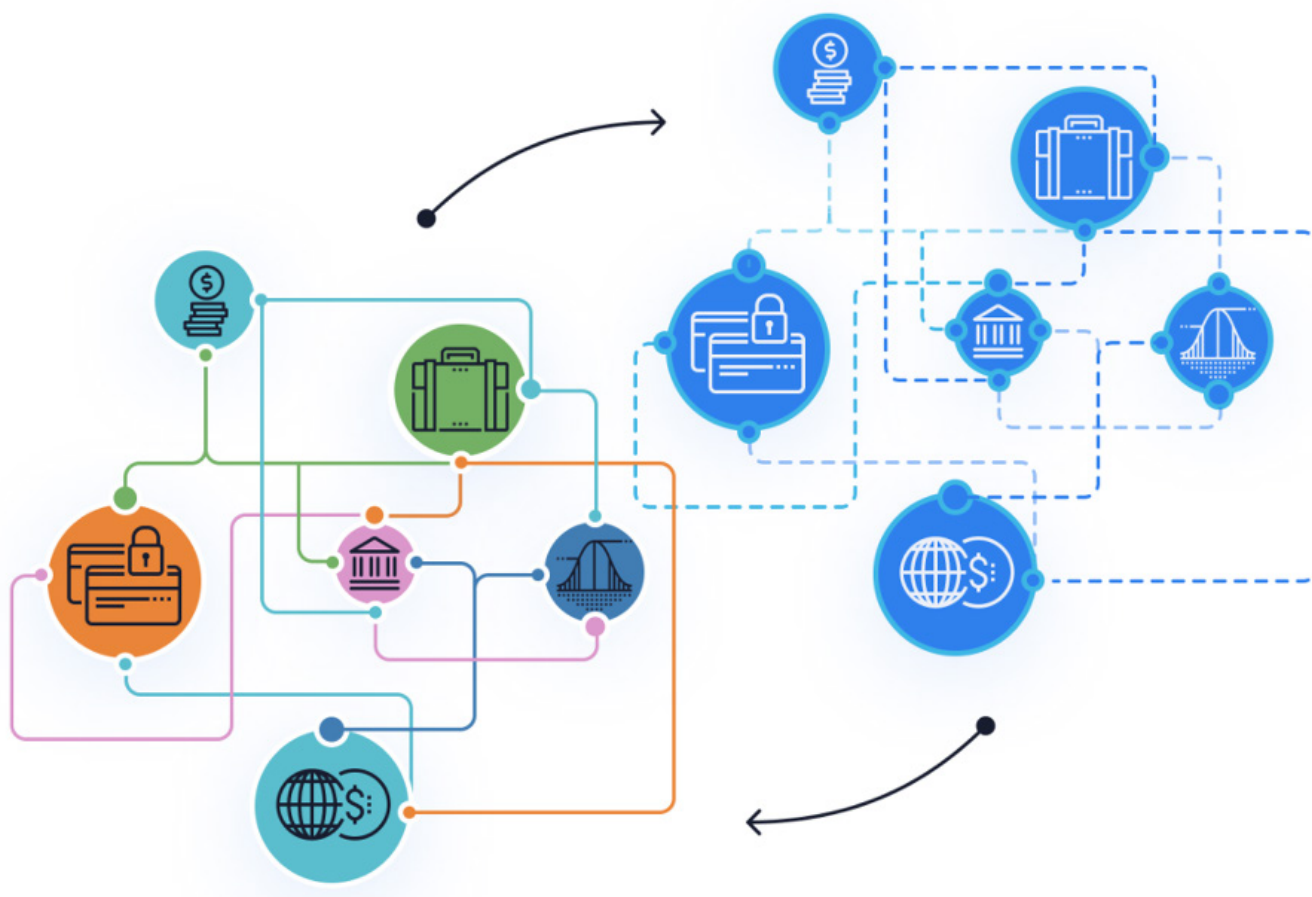
twin of the new Lynx system and used it to explore liquidity saving mechanisms (LSMs) through simulation-based research using actual and artificial Canadian Payments data. A digital twin is a virtual replica of a physical system that can model, simulate, monitor, analyse, and constantly optimize the physical world. Digital twins not only help a financial institution assess how existing systems are performing; they also enable the financial institution to anticipate how these systems, products, or even people could behave in different scenarios.

The Digital Twin allowed Payments Canada to develop multiple scenarios using assumptions for liquidity levels, participant behaviours, and system configurations to simulate outcomes based on several months of historical payments data. Payments Canada analysed the results

of each simulated scenario and used the insights gained to inform the design of the subsequent scenarios.

The benefits of this approach were substantial. By sharing simulation results with LVTS participants, including the Bank of Canada, Payments Canada facilitated a deeper understanding of the new system's functioning, particularly regarding liquidity needs. This transparency allowed participants to question the assumptions in each scenario and actively participate in refining them. This process helped ensure that participants were comfortable with the new system and its liquidity needs well before Lynx's launch, allowing them ample time to prepare their internal processes.

FIGURE 94.
DIGITAL TWIN



Source: [FNA](#)

4.5. Capital markets, securities & investment instruments supervision: Shanghai Stock Exchange's (SSE) fourth generation trading supervision system

The SSE has implemented a cutting-edge fourth generation Trading Supervision System marking a significant leap forward in market oversight and supervisory capabilities.

As financial markets evolve and become increasingly complex, regulatory supervisory bodies face the challenge of staying ahead of market manipulations

and irregularities. The SSE recognized the need for a sophisticated trading supervision system that could harness advanced technologies to monitor and regulate trading activities effectively. The System was developed to address these challenges and provide enhanced market surveillance capabilities.

The new version of the System is a comprehensive solution that leverages advanced technologies, including artificial intelligence, big data analytics, and machine learning, designed to monitor real-time market activities, detect anomalies, and ensure compliance with regulatory standards.

The development, which started in 2016, was executed in two phases:

1. Launched at the end of 2019, this

FIGURE 95.
REALTIME MONITORING SYSTEM



Source: [SSE](#)

phase focused on integrating various business sub-systems to create a unified “one-stop” trading supervision platform. This integration was crucial for streamlining and consolidating the supervision process.

2. Recently completed and operational, this phase introduced advanced real-time computing technology. It emphasised enhancing the back-end computing, substituting and rebuilding the storage architecture. These improvements significantly upgraded the system’s processing performance and its capability for comprehensive analysis.

A pivotal milestone was achieved in 2022 when the SSE formally unveiled its fourth-generation trading supervision system. This marked a significant stride for the SSE in fully embracing the new development concept, fostering the deep integration of technology and business, and constructing a digital intelligent exchange. Leveraging the strengths of its predecessors, the SSE’s System prioritises independent and controllable technologies and information technology innovation.

This strategic approach ensures effective support for the dynamic market supervision requirements that lie ahead, further solidifying its commitment to adaptability and innovation in financial supervision.

The solution features:

Real-time market surveillance

- Continuous monitoring of trading activities in real-time.
- Immediate detection of unusual trading patterns, large price movements, and abnormal order flows.

Big Data analytics

- Integration of vast amounts of historical and real-time trading data.

- Analysis of market trends, liquidity conditions, and historical trading patterns.

Behavioural analysis

- Profiling of market participants based on historical trading behaviour.
- Identification of deviations from normal behaviour, flagging potential market manipulations or insider trading.

Machine learning algorithms

- Implementation of advanced machine learning models for predictive analytics.
- Continuous learning and adaptation to evolving market dynamics and manipulation tactics.

Automated alerts and notifications

- Generation of automated alerts for potentially suspicious activities.
- Customisable alert thresholds and risk parameters for different types of securities.

The implementation process encompassed three primary dimensions:

1. Data integration

- Aggregation of data from multiple sources, including trade executions, order books, and market feeds.
- Integration of historical trading data to establish baseline behaviour.

2. Algorithmic analysis

- Application of machine learning algorithms to identify abnormal patterns and behaviours.
- Calibration and optimisation of algorithms to reduce false positives and negatives.

3. Real-time monitoring

- Deployment of real-time monitoring modules for instantaneous response to market irregularities.
- Seamless integration with trading platforms and exchanges.

The system developed is highly reusable and technically extendable. Its real-time processing performance has been substantially improved compared with the existing system (third iteration), with real-time processing capacity of transaction data expanding as shown in the figure 96.

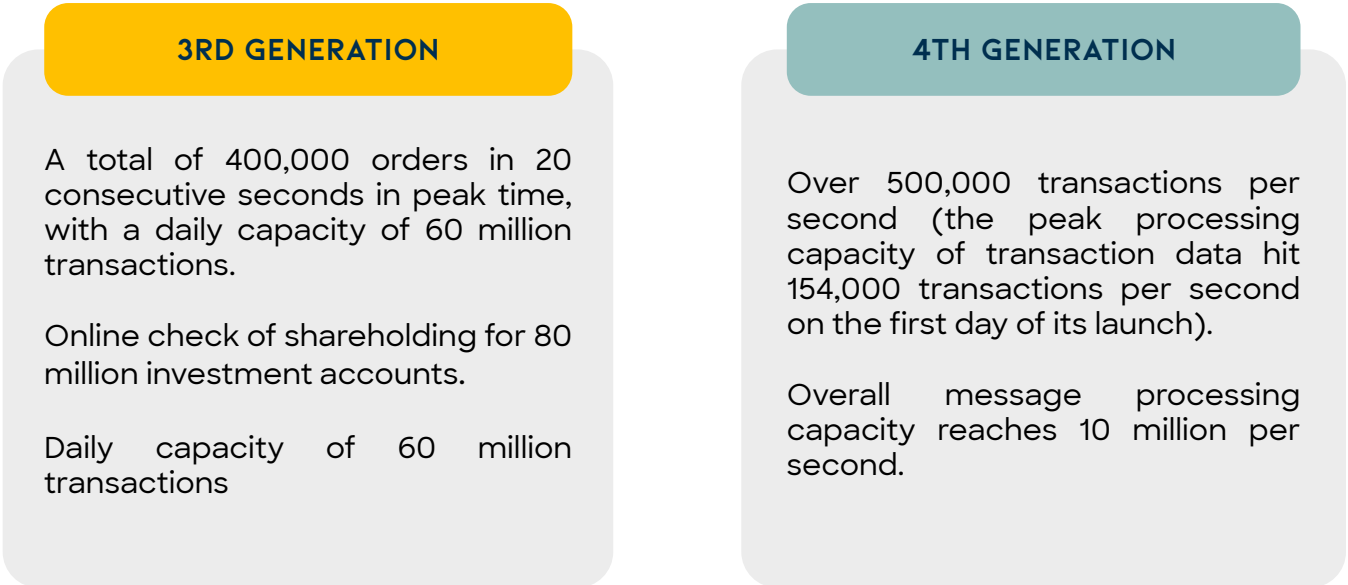
The fourth iteration of the SSE Trading Supervision System has been instrumental in fortifying the integrity of the market. By significantly cutting down on the prevalence of market manipulation and fraudulent activities, it has restored and bolstered investor confidence. This has created a more reliable and ethical trading environment, where participants can engage with greater assurance in the fairness of the operations.

In the realm of investigations, the system’s impact is equally profound. Its capacity to promptly detect suspicious activities has empowered regulatory bodies to act swiftly, ensuring that any potential infractions are addressed before they can burgeon into larger issues. Moreover, the investigative processes have been refined, now characterised by efficiency

and the provision of actionable insights that lead to more effective resolution of cases.

Adaptability is another cornerstone of the system. It has been designed with advanced learning capabilities that allow it to keep pace with the continuously changing market conditions. This attribute is critical in maintaining a vigilant stance against complex and evolving trading strategies, ensuring that the market’s integrity is upheld even in the face of increasingly sophisticated manipulation tactics. The System’s dynamic nature thus fosters a robust and adaptable market environment, capable of withstanding the multifaceted challenges that come with financial evolution.

FIGURE 96.
EVOLUTION OF SSE’S TRADING SUPERVISION SYSTEM: IMPACT AND RESULTS



Source: [SSE](#)

4.6. Cyber risk supervision: The Bangko Sentral ng Pilipinas (BSP) strengthening the industry's cybersecurity deploying the Advanced SupTech Engine for Risk-Based Compliance (ASTERisC*)

As BSP supervised financial institutions [increasingly leverage](#) digital platforms in the provision of essential financial services, massive amounts of data and information are being accessed, stored, processed, and/or transmitted across various systems and networks by BSFIs' customers, third party providers and other external stakeholders. Moreover, alternative working arrangements allow BSFIs' employees to remotely access internal systems and applications which may potentially expose sensitive and confidential information, if not properly secured and managed. Likewise, the adoption of cloud computing platforms and services by BSFIs adds complexity and challenges in ensuring data security, integrity, and privacy.

With these emerging trends in the technology and cybersecurity landscape, risks on data breaches or data leaks become a significant concern leading to reputational, operational, legal, and regulatory risks, among others. These data breaches may occur due to simple errors such as sending an email to incorrect recipients, misplacing or theft of an unencrypted storage media, or utilising a free digital platform without understanding the terms and conditions of its use. They may also arise from exploits on systems and network vulnerabilities, improper access rights management, or insider misuse of information.

BSP recognised this need for bolstering cybersecurity practices within the financial industry, particularly in the face of rapidly evolving cyber threats. With the growing popularity of digital channels especially during the pandemic, cyber-attackers and scammers are increasingly targeting financial consumers to defraud them of their hard-earned money. The conventional methods of supervision proved inadequate for effectively safeguarding the sector against these cyber risks.

ASTERisC* is an AI-driven suptech engine developed by BSP, designed to provide real-time monitoring, risk assessment, and compliance validation across the financial sector. ASTERisC* is a cloud-based solution which supports the BSP's end-to-end process on cybersecurity supervision and oversight to include cyber-profiling, cyber incident reporting and cybersecurity control self-assessments, among others.

With this platform, BSP supervised financial institutions can directly access and transmit cybersecurity-related reports and information in real-time. The system likewise enables deeper analyses and correlation capabilities to help the BSP implement risk-based and proactive supervisory decisions and set policy direction on cybersecurity.

The solution features:

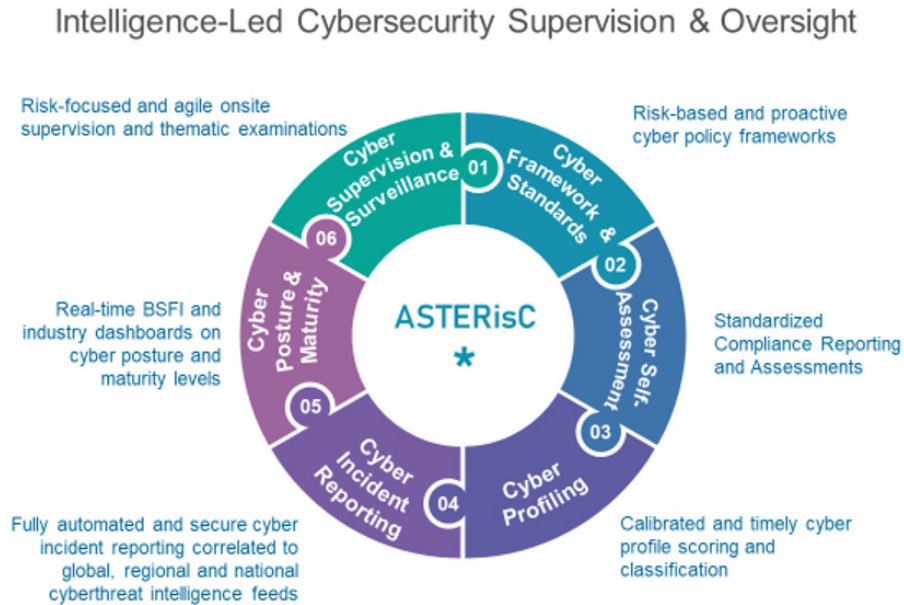
Real-time threat monitoring

- ASTERisC* continuously monitors network traffic, system logs, and user activities in real-time.
- Immediate detection of anomalous behaviour, potential cyber threats, and vulnerabilities.

Behavioural analytics

- Behavioural analysis identifies deviations from normal patterns, enabling early detection of insider threats and sophisticated cyber-attacks.

FIGURE 97.
COMPONENTS OF BSP'S ASTERISC SOLUTION



- Machine learning algorithms adapt to evolving cyber threats, enhancing accuracy over time.

Dynamic risk assessment

- The system conducts dynamic risk assessments based on current cyber threats and vulnerabilities.
- Risk scores are calculated in real-time, allowing for prioritised intervention based on the severity of identified risks.

Comprehensive compliance validation

- ASTERisC* validates compliance with cybersecurity standards and regulations.
- Automated checks against industry best practices ensure a proactive approach to cybersecurity governance.

The implementation process encompassed four primary dimensions:

1. Collaborative data integration

- Integration of data from financial institutions, cybersecurity threat

intelligence feeds, and regulatory standards.

- Collaborative efforts with industry stakeholders ensure a comprehensive and unified cybersecurity approach.

2. Algorithmic analysis

- Advanced algorithms analyse vast datasets to identify patterns indicative of cyber threats.
- Continuous learning and adaptation to emerging threat landscapes enhance the system's effectiveness.

3. Real-time reporting and alerts

- ASTERisC* provides real-time reports and alerts to financial institutions and regulatory authorities.
- Immediate notification of cybersecurity incidents facilitates swift response and mitigation.

4. Capacity-building initiatives

- The BSP conducts capacity-building initiatives to empower

financial institutions with the knowledge and tools to effectively utilise ASTERisC*.

- Training programs and collaborative workshops foster a culture of cybersecurity resilience within the industry.

ASTERisC* has allowed BSP to embrace a proactive approach to cybersecurity governance. By facilitating the early detection and prompt intervention of cyber threats, the system has substantially mitigated the potential fallout from such security incidents. This forward-thinking strategy has not only protected individual institutions but also bolstered the overall resilience of the financial industry. Financial institutions are now more synchronised in their defense against cyber threats, thanks to the adoption of a unified and standardised approach to cybersecurity. This collective fortification has been instrumental in safeguarding the sector's integrity and the trust of its customers.

4.7. Climate/ESG risks supervision: The Monetary Authority of Singapore (MAS) transforming ESG data collection through Project Greenprint.

As a global financial hub, Singapore recognises the critical role it must play in addressing climate change and environmental sustainability. The MAS introduced Project Greenprint to align the financial industry with sustainability goals, drive innovation, and build a resilient and sustainable financial ecosystem.

One of the key challenges faced in sustainability financing and supervision is the difficulty in accessing high quality, consistent and granular sustainability data. Addressing these data gaps will enable financial institutions to direct capital towards sustainability projects in a more scalable way, effectively monitor their sustainability commitments, and quantify the risks and real-world impact of their portfolios.

With corporate sustainability disclosures representing one of the largest sources of ESG data globally, there is great scope to harness technology to enhance such disclosures and comparability of data to support the financing decisions needed for a credible transition. Currently the proliferation of multiple sustainability reporting frameworks and guidelines across jurisdictions, and the inconsistent way data is being collected, verified, and reported have created significant disclosure challenges and resulted in poor ESG data comparability.

To embody the vision of enabling trusted ESG data flows between the financial sector and the real economy, MAS

launched Project Greenprint in December 2020 ([MAS, 2021](#)). This initiative aimed at harnessing innovation and technology to promote a green finance ecosystem through helping to mobilise capital, monitor sustainability commitments, and measure impact.

Since the announcement of Project Greenprint, MAS embarked on engaging the financial industry and other industry sectors to identify potential digital enablers to address the data challenges. These included interoperable data platforms that can aggregate new and existing sustainability data across multiple sectoral platforms and industry players; and enabling sharing of the data across different stakeholders.

Specifically, the MAS set out to work with the industry to pilot four common utility platforms:

1. Greenprint Common Disclosure Portal

In September 2022, MAS and Singapore Exchange (SGX Group) jointly launched ESGenome, a [digital disclosure portal](#) for companies to report ESG data in a structured and efficient manner, and for investors to access such data in a consistent and comparable format. ESGenome is a Software-as-a-Service (SaaS) solution operated by Worldwide Generation (WWG). It helps SGX-listed companies simplify the disclosure process using a core set of metrics that is mapped across global standards and frameworks.

- Companies can carry out their baseline sustainability reporting based on a set of 27 SGX core ESG metrics.
- Companies can make additional disclosures in line with globally recognised ESG reporting standards and frameworks across

more than 3,000 ESG metrics, depending on materiality and their business needs.

- Companies need only provide a one-time input for each ESG metric – these inputs can be automatically mapped across their selected standards and frameworks to cater to different investor requirements. This addresses corporates' current pain points where they must report in different systems, templates, and formats.
- A sustainability report can be automatically generated from the inputs.
- On a consent basis, these data can be shared with authorised recipients, facilitating the transfer of data to multiple stakeholders.

For investors and financial institutions, ESGenome provides access to relevant and comparable ESG data that allows for meaningful peer benchmarking and tracking of sustainability commitments. This enables capital to be mobilised more efficiently toward sustainable companies and projects.

MAS will also draw on the learnings from ESGenome to address the reporting needs of the broader universe of corporates, notably small and medium-sized enterprises, and supply chain partners and suppliers, as part of its ongoing work on Project Greenprint.

2. Greenprint Data Orchestrator,

Through this project, MAS seeks to aggregate sustainability data from multiple data sources, including major ESG data providers, utilities providers, and the Common Disclosure Portal, as well as other sectoral platforms such as GreenON, Olam International and

SGTraDex and provide consent-based access to these key data sources. The platform will enable new data insights to be generated through data analytics to better support investment and financing decisions.

3. Greenprint ESG Registry , developed in partnership with Hashstacs Pte Ltd (“STACS”),

The blockchain-powered data platform aims to support a tamper-proof record of sustainability certifications and verified sustainability data across various sectors, providing financial institutions, corporates, and regulatory authorities a common access point for these data. This will facilitate better tracking and analysis of corporates’ sustainability commitments, impact measurement, alleviate greenwashing risks, and improve management of ESG financial products.

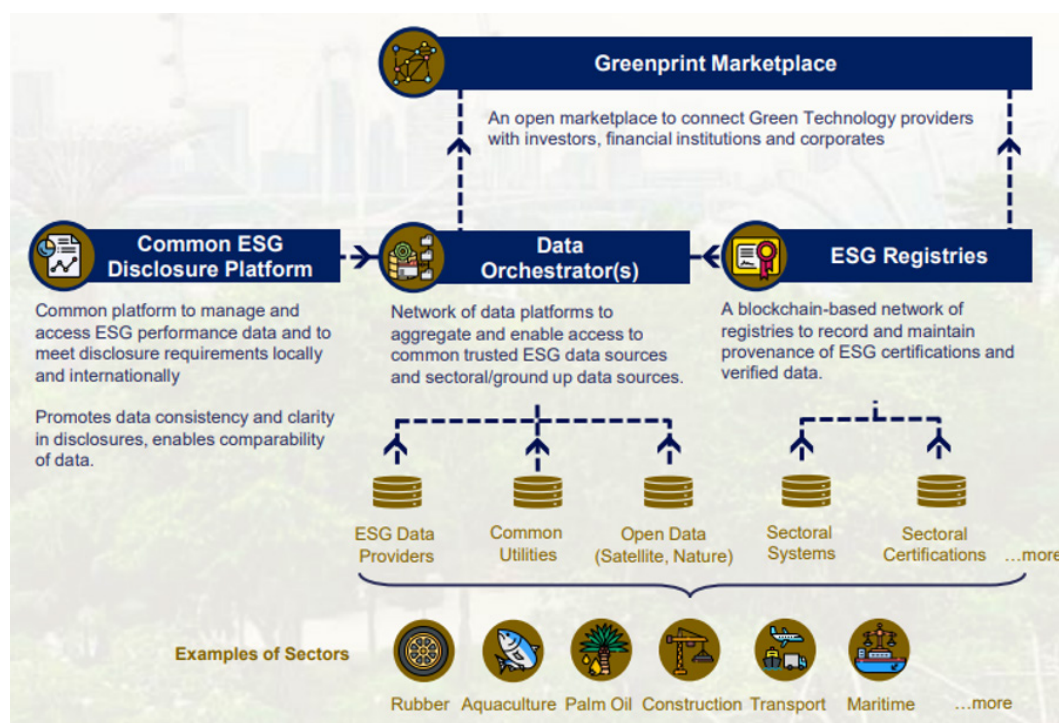
Powered by STACS’ ESGpedia, the Greenprint Registry is currently deployed in its beta phase, with ongoing partnerships with numerous leading financial, non-governmental organisations (NGOs) and a growing ecosystem starting with the agri-food, building and construction, transport and logistics, carbon credit, and renewable energy sectors.

4. Greenprint Marketplace

Developed in partnership with API Exchange (APIX), the solution seeks to connect green technology providers in Singapore and the region to a community of investors, venture capital firms, financial institutions, and corporates to facilitate partnership, innovation and investments in green technology.

This digital platform will provide curated listings of solution providers,

FIGURE 98.
COMPONENTS OF THE MAS PROJECT GREENPRINT



Source: [MAS, 2021](#). Alternative infographic [here](#).

solution seekers and investors to facilitate discovery, acceleration of partnerships and channelling of investments towards green and sustainable solutions and initiatives.

5. Gprint

In November 2023, MAS launched [Gprint](#), an integrated digital platform that harnesses technology to simplify how the financial sector and real economy collect, access and act upon environmental, social and governance (ESG) data to support their sustainability [initiatives](#).

Gprnt is the culmination of MAS' Project Greenprint and offers an enhanced digital reporting solution for both large businesses and small and medium enterprises (SMEs) to seamlessly report their ESG information. This is currently undergoing live testing with selected banks and SMEs and will be progressively rolled out from Q1 2024 onwards. When fully implemented, Gprnt's reporting solution is expected to help companies automate their ESG reporting process, and allow end users (such as financial institutions, regulators, and large corporates) to access relevant data and timely insights to support their sustainability-related decision making. The platform will also synergise across Project Greenprint's existing functions to support enhanced data access and product innovation by the ESG community.

To automate ESG reporting for business, Gprint focuses on addressing challenges related to:

- Data collection - Gprint will pursue integrations with a range of digital systems employed by businesses in their day-to-day activities. These include systems for utilities consumption, bookkeeping and

payroll solutions, building and waste management, payments gateways, and networks for artificial intelligence of things (AIoT) sensors and devices.

- Data computation - Gprnt will translate and compute source data into ESG-related outputs for businesses to report.
- Data access: Businesses have the discretion to decide whom to share their ESG information with.

Lessons through its work on Project Greenprint:

- **Emphasising Collaboration**
MAS has underscored the importance of collaboration through its work on Project Greenprint, partnering with various industry players. This collaborative approach was crucial for launching the ESGenome portal and the introduction of the Gprint platform in 2023. In the realm of supervisory technology (suptech), such partnerships are vital for creating scalable and adaptable solutions, catering to the dynamic needs of financial authorities amid digital transformation and for the wider suptech ecosystem.
- **Maximising Technology and Data for Sustainability**
MAS has recognized the critical role of reliable data flows and the use of technology in supporting sustainability goals, as demonstrated by the initiation of Project Greenprint. Suptech plays a key role in enabling financial authorities to enhance their data collection and analytics capabilities, particularly for evaluating climate and ESG risk management in financial institutions.

4.8. Insurance supervision: National Association of Insurance Commissioners (NAIC) risk dashboards to analyse and visualise solvency risks

In the insurance industry, effectively assessing solvency risks is important for upholding financial stability. Traditional approaches to analysing the operations of insurers, however, often falter in terms of efficiency and clarity. Recognising this challenge, the NAIC identified an opportunity to [enhance solvency](#) risk assessment by creating comprehensive dashboards. These dashboards were envisioned to offer a holistic perspective on solvency risks across various operational facets, thus addressing a crucial need within the insurance industry.

In 2021, the NAIC worked with a vendor to implement AI/ML models to estimate the potential solvency risk associated with individual insurers. These [models](#) were formulated based on over a decade of historical financial data from life insurers in the United States, encompassing failure/insolvency data and specific criteria. One model adopted a decision tree approach, while another took the form of a generalised linear model. The models' efficacy was assessed against real failure outcomes, and calibration was conducted to optimise their performance. Furthermore, additional data points and variables were scrutinised by the models to enhance their overall effectiveness.

The model was adjusted using NAIC's existing scoring system tools, mainly for Life Insurance, Health and Property/Casualty. The improvements include the removal of existing features/variables that proved non-predictive of failure, the

incorporation of ones newly deemed predictive of failure, and the fine-tuning of the existing ones to optimise their significance.

In order to facilitate supervisory activities, the NAIC also deliberated on employing a business intelligence tool, Tableau, to augment current solvency monitoring tools and reports. This involves creating improved dashboards and visualisations for enhanced data representation, helping supervisors to retrieve and analyse data from relational databases, enabling the generation of impactful visualisations like graphs and maps. This enhances the efficiency of insight generation for identifying variances, risks, and concerns. Moreover, the tool establishes connections with current regulatory data sources, facilitating flexible dashboards that permit mining and manipulation by end users.

NAIC devised seven extensive dashboards to scrutinise and present solvency risks within diverse dimensions of an insurer's operations. The critical areas encompassed by these dashboards included bond holdings, equity holdings, premium writings, and reinsurance. NAIC's objective was to employ these dashboards as tools for more effective evaluation of an insurer's solvency status and the identification of potential risks.

To power these dashboards with the requisite data, NAIC harnessed the capabilities of business intelligence tools. These tools facilitated the integration of data from various regulatory sources, creating a comprehensive repository of information pertaining to insurer operations. This data collection spanned a spectrum of regulatory filings and reports, tailored to suit the unique reporting requirements of different insurance sectors, such as property/casualty, life, and health insurance. This approach ensured that the dashboards could be precisely aligned with the specific

reporting demands of each sector.

By December 2022, U.S. NAIC had successfully tailored the dashboards to accommodate the data submitted by insurers adhering to distinct annual statement filing types. This tailored approach enabled targeted analysis, aligning with the distinct characteristics and reporting practices of each insurance sector.

NAIC's vision extends to the development of additional dashboards that support prudential and conduct supervision, thus broadening the horizons of solvency risk analysis. Furthermore, NAIC aims to provide standardised data sets and templates to end-users. This move is expected to empower stakeholders in the insurance industry by facilitating the creation of customized dashboards and visual representations. The provision of standardised data sets fosters consistency, comparability, and collaboration in the domain of solvency risk analysis. It emerges as a powerful lesson in the realm of data analytics and prudential supervision, highlighting the benefits of customisation and standardisation in addressing complex challenges within the insurance sector.

In its ongoing efforts, NAIC aims to develop further dashboards for solvency monitoring. Simultaneously, the organisation plans to furnish end users with standardised datasets and templates, enabling them to construct personalised dashboards and visualisations according to their specific needs.

4.9. Multiple supervisory areas: Federal Reserve System (FRS) NLP-LEX for text analysis and text summarisation

The Federal Reserve System (FRS) has explored the implementation of Natural Language Processing with Lexical Expansion (NLP-LEX) to improve its operational efficiency and effectiveness. NLP-LEX is a cutting-edge technology that leverages the power of AI/ML to analyse and expand financial text data. FRS traditionally dealt with a vast amount of financial data in the form of reports, news articles, research papers, and regulatory documents. Extracting valuable insights from this data was labour-intensive and time-consuming. By deploying NLP-LEX, FRS aimed to streamline its processes, enhance decision-making capabilities, and stay ahead in the ever-evolving financial landscape.

The implementation process encompassed three primary dimensions:

- **Data integration**
FRS integrated NLP-LEX into its existing data infrastructure, enabling the system to access and process a wide range of financial documents.
- **Training and customisation**
The system was trained on historical FRS data to better understand the unique language and terminology used within the organisation
- **Real-time analysis**
NLP-LEX was configured to perform real-time analysis of incoming data streams, providing timely insights to FRS personnel.

LEX is now used across the entire FRS, with 15 use cases and counting.

LEX has been repositioned as a platform upon which all FRS supervisors can develop as many tailored use cases as needed. Key use cases include:

- Climate change (to monitor discussions in board packages)
- Cloud adoption
- Board effectiveness
- Consumer compliance (to review quarterly enforcement action updates as well as annual firm assessments in hundreds of business lines)
- Cyber risk (to identify trends in ransomware and other cyber discussions).

Specific LEX use cases have been set up since March 2020 to allow for off-site monitoring and supervision. For example, the Covid use case was set up within just one week to enable effective monitoring of Covid chatter in response to the remote working setup.

Internal resources have been used at every stage, including data scientists, software developers and line supervisors to develop the tool. It was decided not to

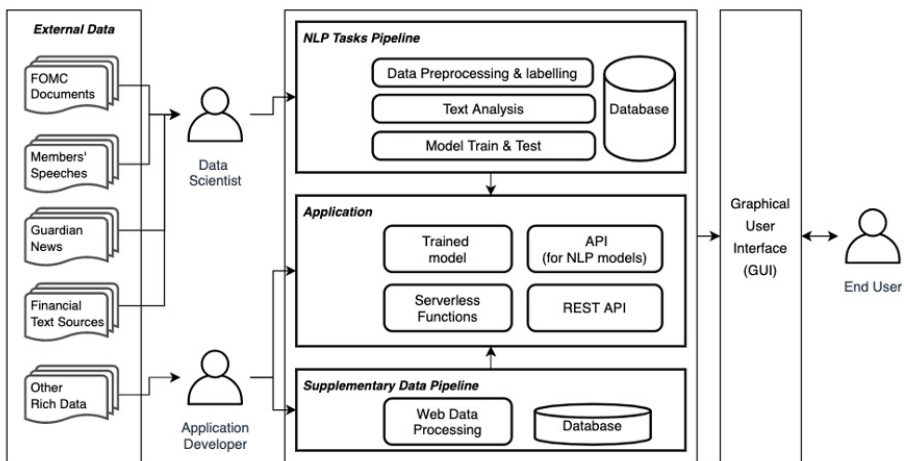
use external resources because of the confidential nature of the supervisory information and inflexibility of the vendor products.

The introduction of NLP-LEX has brought significant efficiency gains to the FRS, streamlining the processing and analysis of voluminous financial documents. This leap in productivity freed the staff to dedicate their expertise to higher-level, strategic tasks. Moreover, the precision of the FRS’s decision-making processes has seen considerable improvement, thanks to the system’s adeptness at distilling essential insights from unstructured data, thus enhancing the overall quality of decisions.

In terms of risk management, NLP-LEX has been pivotal in providing continuous surveillance over financial texts, enabling the FRS to swiftly pinpoint and address emerging risks and trends within the financial sector.

However, the deployment of NLP-LEX was not without its challenges. Paramount among these was the necessity of high-quality input data. The FRS recognised that the effectiveness of NLP-LEX was contingent on the cleanliness and precision of the data fed into it, prompting substantial investment in data cleansing

FIGURE 99.
FUNCTIONAL SYSTEM FLOW OF THE FEDNLP

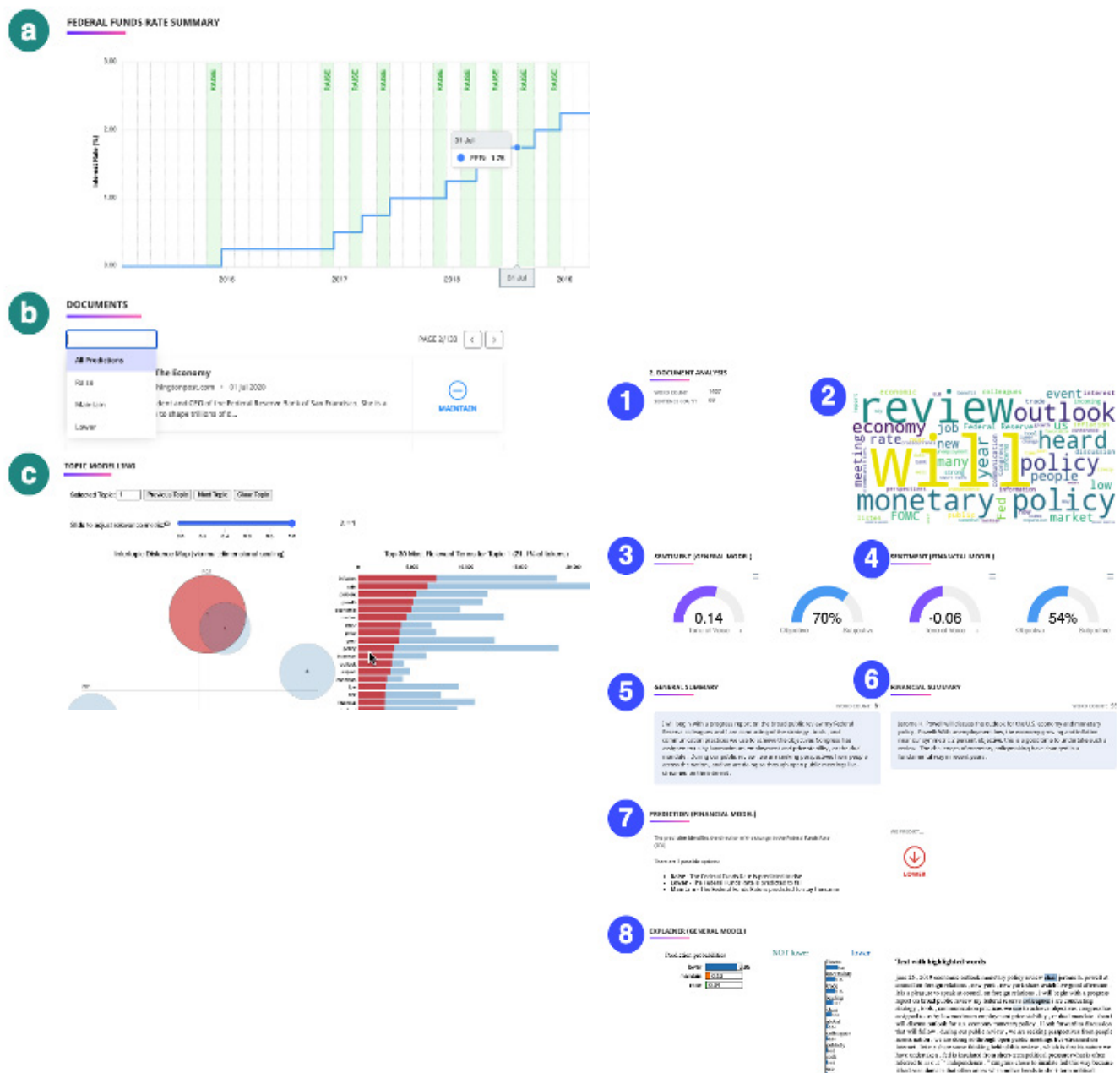


Source: [Lee et al, 2021](#)

As the FRS grappled with an expanding torrent of financial data, scaling the NLP-LEX infrastructure became an imperative to ensure the system could manage the burgeoning workload without compromise.

top priority. To this end, the FRS enforced rigorous security protocols to safeguard the sensitive information being processed, ensuring that NLP-LEX operated within a secure and protected framework.

FIGURE 100.
FIGURE 101: FEDNLP SYSTEM COMPONENTS



Source: [Lee et al. 2021](#)



5. CONCLUSIONS

The State of SupTech Report illustrates the rapid evolution of financial supervision around the world, propelled by advancements in technology and data science, as financial authorities grapple with the necessity to modernise their methodologies and IT infrastructure. This evolution is critical to remaining aligned with the fast-paced changes in the financial markets and tackling new challenges effectively, ensuring both adaptability and resilience in supervision.

Globally, financial authorities are increasingly exploring and integrating cutting-edge technologies in their operations. This trend is evident in various aspects, from improved supervisory mechanisms to enhanced regulatory compliance and risk assessment techniques. However, this technological advancement is leading to a widening gap between affluent and lower-income countries.

The latter are striving to catch up in various facets of their digital transformation journey and seeking additional resources and training to fully leverage the advantages of supotech advancements.

The deepening divide in the digital transformation of financial authorities poses several risks and challenges. Some of these include:

- **Increased cost of business for financial institutions in LICs.** Financial institutions in countries where the supervisory agencies are lagging in the upgrade of their systems may face higher compliance costs. This is because they cannot benefit from the efficiencies enabled by advanced compliance technologies. As a result, these institutions and countries might become less competitive globally.
- **Exclusion from international financial networks.** Financial authorities in LICs

may find themselves increasingly isolated from cross-border supervisory networks and international cooperation efforts. This isolation can limit their access to vital information and resources, making it difficult to effectively monitor and regulate cross-border financial activities.

- **Access to international financial markets.** Outdated and inefficient supervisory methodologies and systems may affect a country's credibility in international financial markets and might lead to increased borrowing costs, reduced investment, and a more cautious approach from foreign investors.
- **Impact on credit ratings.** Credit rating agencies may factor in the effectiveness (or lack thereof) of financial authorities' oversight in the definition of the country's credit rating. A lower rating could potentially lead to a downgrade in the country's credit rating, affecting its ability to borrow money and the terms of such borrowings.

These risks highlight the need for concerted efforts to support digital transformation in the financial regulatory frameworks of LICs, ensuring global financial stability and inclusive growth.

Across all geographies, financial authorities still find themselves navigating through the murky waters of outdated systems, grappling with the cumbersome weight of manual processes and antiquated technologies that have long hampered their operational agility. The trek through this technological quagmire is driven by the pressing need to address long-standing challenges associated with data collection, validation, and storage. Despite the slow pace and the complexity of the journey, the Report

shows a growing recognition among supervisors of the transformative potential that the latest generations of suptech hold.

This awareness is fueled by the promise of suptech innovations that offer gateways to vast, enriched data sets and advanced analytical tools, heralding a new era for financial supervision. Generative AI is the latest technological advancements to inspiring further optimism and anticipation for the transformative potential to reshape financial supervision.

By harnessing cutting-edge solutions, financial authorities anticipate a paradigm shift that could drastically enhance the effectiveness and efficiency of their oversight functions. The vision is one of a supervisory landscape that is not only more robust and responsive but also one that is characterised by unprecedented levels of insight and foresight.

Through these technological advancements, financial authorities are poised to transcend the limitations of their existing frameworks, moving towards a more integrated and intelligent supervisory ecosystem. This evolution in suptech is expected to deliver sophisticated analytics capabilities, empowering authorities to identify and act on risks with a precision and speed previously unattainable. In turn, this could lead to a significant uplift in the overall health and stability of the financial system, as well as a greater capacity to foster trust of consumers and safeguard the interests of the investors.

The journey ahead for financial authorities is one of transformation and discovery, as they continue to pull away from the inertia of the past and move towards a future where data-driven supervision is the norm. With each step forward, they are drawing closer to realising the full potential of suptech, opening doors to innovative regulatory approaches that were once beyond reach.

The integration of new procedures into existing frameworks demands careful strategising and can be impeded by entrenched organisational habits and structures. Moreover, outdated procurement regulations must be revisited to enhance the agility and responsiveness of financial authorities and allow them to truly harness the full potential of technological advancements.

The insights gleaned from the survey findings, the case studies, [SupTech Week](#), and the iterative engagements of the Lab with hundreds of supervisors across the globe suggest that there is increasing consensus of the potential of suptech, and growing evidence of its benefits. They also provide evidence that navigating these challenges requires a well-considered, step-by-step approach, underscored by strong leadership, overall agility, and widespread collaboration across the ecosystem, which all help navigate the complexities of this transformative journey.

In the ever-evolving technological landscape and financial sector, financial authorities must chart a course through the suptech frontier with adaptability, collaboration, and an unwavering commitment to innovation.

With 81% of respondents acknowledging the fundamental and strategic importance of suptech, it is evident that the field is on the cusp of a significant transformation. The widespread adoption of strategies and tools to support the evolving financial sector's supervision is well underway. However, rather than signaling that we are approaching the conclusion of this journey, this marks the end of the initial phase, offering valuable lessons for the road ahead.

For instance, this report highlights that suptech systems aren't monolithic enterprise solutions but instead consist of supervisory stacks comprising multiple

use-case-centric applications. According to the survey, 86.5% of authorities using suptech have various applications in operation. The case studies demonstrated that these apps often integrate with each other. Furthermore, these solutions demand expertise for maintenance and deployment. Overall, this entails cultivating a mindset and acquiring the necessary tools for continuous innovation, fostering an environment where collaboration thrives through the crowding of funds and talent, and the sharing of information, knowledge, code, algorithms, and more. Today, it's AI, tomorrow, quantum computing, and next week, the next disruptive technology, each challenging the existing supervisory approaches and data structures, and each providing the next opportunity to augment and enhance the supervisors' capabilities.

Leadership's pivotal role in fostering innovation is evident through their encouragement of experimentation, risk-taking, and the promotion of technical capacity building to facilitate effective suptech integration.

Leadership plays a pivotal role in driving innovation within supervisory agencies. Leaders appear cognisant and supportive of the opportunities to harness the suptech opportunities. They are increasingly fostering a culture of experimentation and continuous improvement, which includes promoting problem-solving and a mindset that values calculated risk-taking. In this environment, failure is viewed as an opportunity for learning, and leaders demonstrate strong yet flexible convictions, embracing the discomfort of navigating ambiguity.

The Report also underscores the critical importance of technical capacity building for executives to effectively integrate innovative strategies and data-driven decision-making.

Leaders also recognise that this

transformative journey hinges on enhancing the human capital within their organisations. Providing the workforce with skills in data science, business analysis, product design, and tech development is imperative to refining supervisory models. Consequently, there is a pressing need for continuous learning and professional development programs. The survey results highlight a persistent and high-priority demand for suptech and digital transformation training among financial authorities. Such training programs are essential for understanding the evolving financial landscape, updating supervisory methods, cultivating essential technical skills, fostering an innovative organisational culture, and introducing crucial practices like human-centred design (HCD) to develop solutions that align with the practical needs of supervisors, financial institutions, and consumers alike.

Particularly important is [experiential training](#), which involves hands-on learning experiences and simulations that allow supervisors, data scientists and others to develop practical skills in real-world scenarios. This type of training helps bridge the gap between theory and practice, preparing participants for the dynamic and complex challenges they may face in their roles.

A new paradigm of collaboration is taking shape, and is here to stay.

In the evolving world of financial supervision, a new paradigm of collaboration within the suptech ecosystem is emerging and establishing a permanent footprint. This collaboration is igniting a wave of innovation and efficiency. Digital transformation has ushered in an era where cooperation extends beyond the walls of individual financial authorities, influencing interactions across the entire financial ecosystem and within the technology sector, and bridging both domains. As digital transformation propels forward,

financial authorities are embracing this collaborative ethos not just internally but also across their global networks, and enhancing their interactions with financial institutions and consumers alike.

Within this context, a diverse group of professionals – e.g., supervisors, technologists, data analysts, and data scientists – are uniting their expertise to maximise the potential of suptech. They are dedicated to advancing the development of cutting-edge suptech solutions, and are equally committed to ensuring the security of these systems identifying vulnerabilities and protecting sensitive data against emerging threats. They are also driving the application of the highest ethical standards to the deployment of advanced technologies both in the financial sectors and by the supervisory agencies.

This collaborative force extends its reach beyond domestic frontiers, as financial authorities acknowledge the necessity of international cooperation, especially in the supervision of globally operating financial institutions and digital assets. Here, they strive for harmonisation through the establishment of shared standards, covering data formats, reporting protocols, and cybersecurity measures, which serve to bolster efficiency and ensure suptech systems' interoperability across countries. Pooling talent and financial resources has become another facet of this collaborative effort.

Financial authorities are discovering the benefits of combining their strengths for joint projects. Moreover, collaboration includes a proactive engagement with financial service providers and financial consumers. Where regtech and suptech converge, they result in streamlined compliance processes and substantial cost reductions for financial institutions and more efficient validation by authorities. Now more than ever, authorities are also leveraging consumer feedback to deepen

their understanding of market challenges and improve their regulatory approaches. Vice-versa, by sharing data and insights they can empower consumers and their representative associations, facilitating informed financial decisions that drive transparency and competition in the marketplace.

In a spirit of open collaboration, the open sourcing of suptech solutions – or some of their components – has also been explored, thereby sharing algorithms, tools, and methodologies, which accelerates the adoption of new applications at scale and invites collective efforts in the development and enhancement of oversight tools.

Within the limits of regulations and security, the exchange of algorithms can allow financial authorities to better the methodologies underlying their supervisory processes, fostering a shared understanding and facilitating the adoption of best practices. Open-source initiatives in code sharing can also galvanize the community, enhancing transparency, and inviting innovation, while also underlining cost efficiency and the optimisation of resources.

The role of APIs is pivotal in this collaborative infrastructure, as they enable the secure and standardised exchange of data between different suptech systems. APIs are the technological bridges that facilitate the effective sharing of data, ensuring seamless integration and enhancing the efficiency of regulatory processes.

Finally, the examples of collaboration among suptech vendors show the potential to significantly enhance the services they provide to financial authorities. By joining forces, these vendors have created comprehensive solutions that leverage each other's strengths. Vendors' partnership could result in a unified service that interprets complex data and also presents it in a

more accessible manner for supervisors via united access points with unique logins and integrated dashboards that offer a comprehensive, multilayered view, drawing from various data sources and analytics tools. This would streamline the supervisory process while providing deeper insights and a more robust oversight capability.

In summary, collaborations in the suptech ecosystem mark a significant shift towards a more interconnected and innovative approach to financial supervision, and underlines a collective commitment to progress and efficiency that benefits all stakeholders in the financial system. This collaborative approach is not a transient trend, but a substantial and lasting transformation that promises to continue shaping the future of financial supervision.

Digital tools underpin collaboration across the ecosystem and one-to-many capacity building and technical assistance to facilitate knowledge sharing and deliver impact at scale.

The research findings emphasise the challenges and resource-constraints on both the demand and the supply side of the suptech marketplace. To address these limitations and foster efficient collaboration, knowledge sharing and capacity building, the development of [digital tools](#) – that integrate digital public goods, open platforms, and shared resources – becomes imperative to accelerate the digital transformation of financial supervision on a global scale.

The background is a dark blue collage of various business and data visualization elements. It includes several pie charts of different sizes, some with highlighted segments. There are also line graphs showing trends over time, bar charts, and dashboard-like interfaces with multiple small charts and data points. One dashboard in the upper left is titled 'Sales Promotion' and features a grid of small circular indicators. Another dashboard in the lower right shows a large bar chart with a line graph overlay. The overall aesthetic is modern and data-driven.

6. APPENDIX

APPENDIX 1: LIST OF RESPONDENTS

FINANCIAL AUTHORITY	JURISDICTION	INCOME LEVEL	TYPE OF FINANCIAL AUTHORITY
Banco Nacional de Angola	Angola	Lower middle income	Central Bank
Central Bank of Argentina	Argentina	Upper middle income	Central Bank
Australian Prudential Regulation Authority	Australia	High income	Other
Financial Market Authority Austria	Austria	High income	Capital market, securities and investment instruments
Bangladesh Bank	Bangladesh	Lower middle income	Central Bank
Bermuda Monetary Authority	Bermuda	High income	Central Bank
Banco Central do Brasil	Brazil	Upper middle income	Central Bank
Bulgarian National Bank	Bulgaria	Upper middle income	Central Bank
Financial Transactions and Reports Analysis Centre of Canada	Canada	High income	Other
Office of the Superintendent of Financial Institutions	Canada	High income	Other
Financial Market Commission	Chile	High income	Other
Financial Superintendency of Colombia	Colombia	Upper middle income	Other
Banco de la República	Colombia	Upper middle income	Central Bank
Superintendencia General de Valores	Costa Rica	Upper middle income	Capital market, securities and investment instruments
Superintendencia de Economía Popular y Solidaria	Ecuador	Upper middle income	Other

Central Bank of Eswatini	Eswatini	Lower middle income	Central Bank
European Central Bank	European Union	High income	Central Bank
European Insurance and Occupational Pensions Authority	European Union	High income	Other
Reserve Bank of Fiji	Fiji	Upper middle income	Central Bank
Bank of Ghana	Ghana	Lower middle income	Central Bank
National Pensions Regulatory Authority	Ghana	Lower middle income	Other
Banque Centrale de la Republique de Guinee	Guinea	Lower middle income	Central Bank
Comisión Nacional de Bancos y Seguros	Honduras	Lower middle income	Other
Reserve Bank of India	India	Lower middle income	Central Bank
Bank Indonesia	Indonesia	Upper middle income	Central Bank
Otoritas Jasa Keuangan	Indonesia	Upper middle income	Other
Central Bank of Kenya*	Kenya	Lower middle income	Central Bank
Capital Markets Authority Kenya	Kenya	Lower middle income	Capital market, securities and investment instruments
National Bank of the Kyrgyz Republic	Kyrgyz Republic	Lower middle income	Central Bank
Bank of Latvia	Latvia	High income	Central Bank
Bank of Lithuania	Lithuania	High income	Central Bank
Securities Commission Malaysia	Malaysia	Upper middle income	Capital market, securities and investment instruments
Republic of Marshall Islands Office of Banking Commission	Marshall Islands	Upper middle income	Other

Financial Services Commission	Mauritius	Upper middle income	Other
Secretariat of Finance and Public Credit	Mexico	Upper middle income	Other
National Bank of Moldova	Moldova	Upper middle income	Central Bank
Financial Regulatory Commission of Mongolia	Mongolia	Lower middle income	Capital market, securities and investment instruments
Central Banka of Montenegro	Montenegro	Upper middle income	Central Bank
Moroccan Capital Market Authority	Morocco	Lower middle income	Capital market, securities and investment instruments
Banco de Moçambique	Mozambique	Low income	Central Bank
De Nederlandsche Bank	Netherlands	High income	Central Bank
Securities and Exchange Commission	Nigeria	Lower middle income	Capital market, securities and investment instruments
National Bank of the Republic of North Macedonia	North Macedonia	Upper middle income	Central Bank
Superintendencia de Banca, Seguros y AFP	Peru	Upper middle income	Other
Bangko Sentral ng Pilipinas	Philippines	Lower middle income	Central Bank
Securities and Exchange Commission	Philippines	Lower middle income	Capital market, securities and investment instruments
Qatar Financial Centre Regulatory Authority	Qatar	High income	Other
National Bank of Rwanda	Rwanda	Low income	Central Bank
Banque Centrale des États de l'Afrique de l'Ouest	Senegal	Lower middle income	Central Bank
Securities Commission of the Republic of Serbia	Serbia	Upper middle income	Capital market, securities and investment instruments
Bank of Sierra Leone	Sierra Leone	Low income	Central Bank

Central Bank of Solomon Islands	Solomon Islands	Lower middle income	Central Bank
Central Bank of the Republic of China (Taiwan)	Taiwan	High income	Central Bank
Bank of Tanzania	Tanzania	Lower middle income	Central Bank
Banco Central de Timor-Leste	Timor-Leste	Lower middle income	Central Bank
Central Bank of Trinidad and Tobago	Trinidad and Tobago	High income	Central Bank
Bank of Uganda	Uganda	Low income	Central Bank
National Bank of Ukraine	Ukraine	Lower middle income	Central Bank
Bank of England	United Kingdom	High income	Central Bank
Financial Conduct Authority	United Kingdom	High income	Other
Palestine Capital Market Authority	West Bank and Gaza	Upper middle income	Capital market, securities and investment instruments
Bank of Zambia	Zambia	Lower middle income	Central Bank
Securities and Exchange Commission of Zimbabwe	Zimbabwe	Lower middle income	Capital market, securities and investment instruments

* The survey response from the Central Bank of Kenya was received after the closure of the analysis period, and as a result, it was not included in the final analysis presented in the Report.

APPENDIX 2: SUPTECH TAXONOMY

SUPERVISORY AREAS

Supervisory Area	Supervisory Use Case	Description
Anti-money laundering/ counter-terrorism financing and proliferation (AML/CFT/ CPF) supervision	Assisted/automated examination	Assist subject examination and investigation
	KYC/EDD assessment	KYC, and name/entity and or address matching
	Suspicious activity detection	Suspicious activity detection and classification
	Misconduct analysis	Data analytics on misconduct (AML, fraud, mis-selling)
	Metadata intelligence	Metadata on AML/CFT/CPF reports submitted to Financial Intelligence Unit (FIU)
	Advanced text analysis	Examination of supervised firms' (and local and foreign subsidiaries) policies (e.g., customer identification and beneficial ownership measure, implemented simplified CDD for lower risk customers) and training materials
	Derisking analysis	Data on derisking (e.g., how were the risks assessed, how many correspondents and customers were affected)
Capital market, securities and investment instruments supervision	Onsite examination	Onsite examination
	Market manipulation detection	Identify market manipulation
	Insider trading detection	Identify insider trading
	Improved insights	Extract insights from financial advice documents
	Poor disclosure detection	Identify and assess poor market disclosure by listed companies
	Onsite inspection	Onsite inspection
Competition monitoring	Risk-based prioritisation	Prioritisation of risks
	Competition monitoring	Monitor competition dynamics in the market (e.g., market share)
	Fees and rates monitoring	Monitor rates and fees

Compliance assistance	Automated guidance	Clarify compliance requirements
	Automated compliance auditing	Automated compliance auditing (e.g. via workflows on a Regulatory Information and Workflow Management System, RIS)
Climate/ESG risks supervision	Risk classification	Collection and analysis of sustainable finance data for risk identification and assessment
	Green market monitoring	Monitoring green market dynamics
	Scenario analysis	Stress testing and scenario analysis
	Portfolio analysis	Portfolio analysis
Consumer protection and market conduct supervision	Consumer fraud detection	Consumer fraud detection and prevention
	Complaints handling	Facilitate complaints handling and resolution
	Complaints analysis	Complaints data analysis
	Complaints monitoring	Real-time complaints monitoring
	Algorithmic auditing	Detect algorithmic bias/error
	Sentiment analysis	Sentiment analysis of web and social media content
	Templates validation	Terms and conditions, privacy policy, and consent management validation
	Interdepartmental analysis	Analysis of interdepartmental data (e.g. stacking market conduct supervision data with prudential supervision data)
	Cross-entity analysis	Cross-entity analytics (stacking multiple data sources)
	Early warning systems	Dynamic diagnostic & early warning systems
	Onsite examination	Onsite examination
	Peer-group/risk classification	Peer group identification and risk classification
	Misconduct analysis	Detect and identify risk indicators of misconduct with financial promotions targeting and/or exploiting vulnerable consumers

	Predatory pricing detection	Identify predatory pricing
	Poor disclosure detection	Identification of pre-contractual and contractual information formats with misleading information or poor disclosure
	Credit bureau rectification	Credit reference bureau checks and correction by consumers
	Alternative dispute resolution	Alternative dispute resolution
Cyber risk supervision	Cybersecurity assessment	Assessments of vulnerabilities, application security, access privileges, penetration testing
	Audit trail examination	Audit trail examination and analysis
	Compliance monitoring	Compliance monitoring (CISO, data security and retention policy, multi-factor authentication, incidence response plan)
	Onsite inspection	Onsite inspections
Digital assets / cryptocurrencies oversight	Data handling	Data handling (managing regulatory data, facilitating remote access, stacking multiple data sources)
	Automated compliance auditing	Automated compliance auditing (e.g. via workflows on a Regulatory Information and Workflow Management System, RIS)
	Automated data validation	Automated validation of incoming data (including via embedded supervision)
	On-chain analysis	On-chain analysis for either targeted investigations or to monitor global/regional flows (i.e. identify suspicious activity, investigate cryptoasset activity, visualize transactional relationships)
	Cross-jurisdictional analysis	Cross-jurisdictional intelligence checks and information-sharing capacity
Financial inclusion monitoring	Gender-based analysis	Gender disaggregated data
	Simplified KYC assessment	Analysis of implemented simplified customer due diligence (CDD) measures for lower risk customers (how many customers benefit from these measures, gender, location, etc)

	Geospatial analysis	Analysis of geographical trends (e.g. mapping access points, regional gaps in services)
	Advanced/real-time monitoring	Automated and real-time monitoring & evaluation of progress towards national targets set-up for increasing financial inclusion
	Consumer education	Financial literacy/awareness/communication
	Consumer satisfaction analysis	Analysis of DFS consumer satisfaction rates (e.g. via chatbot analytics, mining of social media sentiment)
Insurance supervision	Data handling	Data handling (managing regulatory data, facilitating remote access, stacking multiple data sources)
	Automated compliance auditing	Automated compliance auditing (e.g., via workflows on a Regulatory Information and Workflow Management System)
	ORSA reporting and analytics	Filing and review of ORSAs (Own Risk Solvency Assessments)
	Automated data validation	Automated validation of incoming data (e.g., financial statements, responses to requests for information, technical compliance)
	Stress testing	Stress testing (assesses the impact of events having extreme impact)
	Registration of intermediaries	Registration/authorisation of key stakeholders (intermediaries, salespersons)
	Fit & proper assessment	Fit and proper assessment (directors, officers, shareholders)
	Product registration	Filing/approval of regulated offerings (e.g., new products, advertising materials)
	Risk assessment	Risk assessment of licensees (e.g., solvency, concentration, exposure)
Licensing	Onsite examination	Onsite examination
	Automated guidance	Automated guidance for licence/authorization applications, clarifying licensing requirements based on business model or product characteristics
	Automated processing	Automated processing of licence/authorization applications

Payments oversight	Advanced/real-time monitoring	Advanced (e.g., close to real-time) (on net / off net) volumes and values analysis
	Network performance monitoring	Monitor network performance
	RTGS stress testing	RTGS stress testing
Prudential supervision of banks and non-bank deposit taking institutions	Data handling	Collection and management of regulatory data
	Automated data validation	Automated validation of the integrity and quality of periodic information submitted by supervised entities, including cross-validation
	Interdepartmental analysis	Analysis of interdepartmental data (e.g. stacking market conduct supervision data with prudential supervision data)
	Cross-entity analysis	Cross-entity analytics (stacking multiple data sources)
	Threshold monitoring	Monitoring of relevant threshold compliance and indicators
	Investment patterns analysis	Detection of investment patterns in the portfolios of supervised entities to monitor their risk exposures
	Automated credit examination	Automating the process of reviewing creditworthiness of a bank's borrowers to assess the quality of the bank's credit underwriting, risk management and provisioning frameworks and processes
	Microprudential supervision	Additional use cases related to the microsupervision of credit, market, liquidity and operational risks of banks and non-bank deposit taking institutions, generating reports for supervision and risk analysis
	Risk-based prioritisation	Ratings and analytical tools to establish the supervision priorities of financial institutions (Risk-based supervision)
	Automated report generation	Automated analysis and supervision reports of risk and regulatory compliance of margins and settlements of central counterparties and other financial infrastructures
	Onsite examination	Onsite examination
	Stress testing	Stress testing (assesses the impact of events having extreme impact)

	Scenario analysis	Scenario analysis (focuses on the direct impact of a change in only one event or activity under extreme circumstances)
	Peer-group/risk classification	Peer group identification and risk classification
	Fit & proper assessment	Fit and proper assessment (directors, officers, shareholders)

APPENDIX 3: SUPTECH TAXONOMY

SUPERVISORY DATA STACK

Layer of Supervisory Stack	Technology	Examples
Data Collection	Manual submission	Document-based templates, scanning and sending PDFs, mailing physical files
	Web portals or other document management	Secure web submission interfaces, batch uploads via file servers (SFTP)
	Application programming interfaces (APIs)	RESTful APIs using XBRL, XML, or json formats
	Shared datasets	Pull APIs, data commons
	Advanced collection (e.g., scraping, streaming, AI-based)	Chatbots, web scraping, social media streaming, embedded distributed ledger technology (DLT) supervision
Data Validation	Manual Validation	Spot checks, post hoc validation
	Automated validation	Errors and warnings via web portal messages, API validation rules, spreadsheet template rules.
	Task automation	Scripting of processes via macros, Robotic Process Automation (RPA), extract transform load (ETL) systems
	Advanced processing (e.g., machine learning)	PDF extraction, natural language processing (e.g., sentiment analysis, text mining), advanced image processing (e.g., optical character recognition - OCR, biometrics, and other computer vision - CV)
Data Storage	Physical Media	Paper files, flash drives, compact disks
	File based systems	Shared network drives, collaborative editing platforms
	On-premises databases	Relational databases (SQL), document-based (NoSQL) databases, graph databases
	Cloud/hybrid storage	Cloud databases, data warehouses
	Big Data systems	Data lakes, data marts, search and analytics engines, mapreduce and parallelisation

Layer of Supervisory Stack	Technology	Examples
Data Analytics	Manual / ad hoc analytics	Key performance indicators, statistical summaries, spreadsheets
	Descriptive analytics	Trends and relationships, exploratory data analysis (EDA)
	Predictive analytics	Sentiment and topic modeling, machine learning, recommendation engines, network analysis, other quantitative modelling techniques
	Prescriptive Analytics	Alert and warning systems, simulation and scenario modeling, automated notifications with recommended actions
Data Products	Stats and metrics	Reporting of individual quantitative figures (e.g., key performance indicators)
	Static reports	Manually produced, document-based, statistical reports that include context alongside graphics
	Automated dashboards	Filtered views of charts, Geographic Information Systems (GIS), time series, raw data, etc.
	Advanced interactive platforms	Low-code and no-code interactive visualization platforms with dynamic views for extending reporting, exploratory analysis, case management, etc.
	AI-based business intelligence	Generative AI (ChatGPT by OpenAI, Gemini by Google, Langchain and stable diffusion open source libraries), forecasting, scenario modelling

APPENDIX 4: DEFINITIONS

A

APPLICATION PROGRAMMING INTERFACES (APIS)

APIs allow software programs to interact by exchanging data which can prompt certain actions, such as making a transaction. This includes payment APIs, data APIs, 'ecosystem expansion' APIs and 'consent and identity' APIs. ([World Bank 2020](#))

ARTIFICIAL INTELLIGENCE (AI)

Defined as IT systems that perform functions requiring human capabilities. AI can ask questions, discover and test hypotheses, and make decisions automatically based on advanced analytics operating on extensive data sets. Machine learning (ML) is one subcategory of AI. ([World Bank 2020](#))

B

BIG DATA

High-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation. ([Gartner 2022](#))

BUSINESS INTELLIGENCE (BI)

Software and services to transform data into actionable insights that inform an organisation's strategic and tactical business decisions. BI tools access and analyse data sets and present analytical findings in reports, summaries, dashboards, graphs, charts and maps to provide users with detailed intelligence about the state of the business. The term business intelligence often also refers to a range of tools that provide quick, easy-to-digest access to insights about an organisation's current state based on available data. ([CIO 2019](#))

C

CHATBOT

A computer program that simulates and processes human conversation (either written or spoken), allowing humans to interact with digital devices as if they were communicating with a real person. ([Oracle 2022](#))

CLOUD COMPUTING

A innovation in computing that allows for the use of an online network ('cloud') to host processors, leading to an increase in the scale and flexibility of computing capacity. ([FSB 2020](#))

COMPUTER VISION	A field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos and other visual inputs – and take actions or make recommendations based on that information. Subcategories include image segmentation (where items are in an image) and image classification (what the items are). (R²A 2017)
CONSUMER PROTECTION	The framework of laws, regulations, and institutional arrangements that safeguard consumers by ensuring fair and responsible treatment for them in the financial marketplace. (World Bank 2022)
CYBERSECURITY	Preservation of confidentiality, integrity and availability of information and/or information systems through the cyber medium. In addition, other properties, such as authenticity, accountability, non-repudiation and reliability, can also be involved. (FSB 2018)
D	
DATA LAKES	Centralised repositories designed to store, process, and secure large amounts of structured, semi-structured, and unstructured data. It can store any type of data in its native format and process it, ignoring size limits. (Google 2022)
DATA PROCESSING	The collective set of data actions (the complete data life cycle, including, but not limited to, collection, retention, logging, generation, transformation, use, disclosure, sharing, transmission and disposal). (NIST 2020)
DATA VALIDATION	An activity aimed at verifying whether the value of a data item comes from the given (finite or infinite) set of acceptable values. For example, this ensures a postal code is valid or that a numeric value does not include letters or symbols. These rules can be enforced in either a manual or automatic fashion. (OECD 2013)
DATA VISUALISATION	The graphical representation of data for understanding and communication. This typically takes the form of exploratory (trying to explore and understand patterns and trends within your data) or explanatory (surfacing something in your data you would like to communicate to your audience) forms. (Johns Hopkins University 2022)
DATA WAREHOUSE	A data management system designed to enable and support business intelligence (BI) activities, especially analytics. Data warehouses are solely intended to perform queries and analysis and often contain large amounts of historical data. The data within a data warehouse is usually derived from various sources, such as application log files and transaction applications. (Oracle 2022)

DESCRIPTIVE ANALYTICS TOOLS	interactive applications used to search and summarise historical data to identify patterns or meaning, including dashboards, data visualisation tools and automated statistical summaries. (TechTarget 2022)
DIGITAL ASSETS	Digital instruments issued or represented by using distributed ledger or similar technology. This does not include digital representations of fiat currencies, such as e-money. (FSB 2022)
DIGITAL FINANCIAL SERVICES (DFS)	Refers to services such as payments, transfers, savings, credit, insurance, securities, financial planning and account statements that are delivered via digital/electronic technology, such as e-money, payment cards and a regular bank account. (World Bank 2020)
DISTRIBUTED LEDGER TECHNOLOGY (DLT)	Refers to technology such as blockchain that records information through a distributed ledger (a repeated digital copy of data at multiple locations). These technologies enable nodes in a network to securely propose, validate and record state changes (or updates) to a synchronised ledger distributed across the network's nodes. (World Bank 2020)
F	
FINANCIAL INCLUSION	The uptake and use of a range of appropriate financial products and services by individuals and MSMEs (micro, small, and medium enterprises), provided in a manner that is accessible and safe to the consumer and sustainable to the provider. (World Bank 2020)
FINANCIAL STABILITY	A stable financial system can efficiently allocate resources, assess and manage financial risks, maintain employment levels close to the economy's natural rate, and eliminate relative price movements of real or financial assets that will affect monetary stability or employment levels. Financial stability is paramount for economic growth, as most transactions in the real economy are made through the financial system. (World Bank 2016)
FINTECH	An acronym for 'financial technology'. It refers to the advances in technology that have the potential to transform the provision of financial services spurring the development of new business models, applications, processes, and products. (World Bank 2020)



GENERATIVE AI

A form of Artificial Intelligence that can generate text, images, or other types of media all in response to a simple 'prompt'. These systems learn from patterns and structure of their training data, finally presenting an inspiring piece of new data. Notable examples include chatbots like ChatGPT by OpenAI and Bard by Google, along with AI systems like Stable Diffusion, Midjourney and DALL-E. ([Cambridge SupTech Lab 2023](#))

GEOGRAPHIC INFORMATION SYSTEMS (GIS)

A computerised system for capturing, storing, checking and displaying data related to positions on the Earth's surface, enabling analysis and visualisation based on spatial relationships between this data. ([NatGeo 2022](#))



IMAGE PROCESSING

The general process of digitising and formatting visual information (for example, photographs and video) so useful information can be automatically extracted via technologies such as optical character recognition (OCR), facial recognition and other computer vision techniques. ([R²A 2017](#))

INNOVATION ACCELERATOR

Supports early-stage, growth-driven companies through education, mentorship, and financing. Startups enter accelerators for a fixed period and as part of a cohort of companies. The accelerator experience is a process of intense, rapid, and immersive education aimed at accelerating the life cycle of young innovative companies, compressing years' worth of learning by doing into just a few months. ([HBR 2016](#))

INNOVATION HUB/OFFICE

An Innovation facilitator set up by a supervisory agency that provides support, advice or guidance to regulated or unregulated firms in navigating the regulatory framework or identifying supervisory policy or legal issues and concerns. Unregulated entities can engage with regulators to discuss fintech-related issues (for example, sharing information and views) and seek clarity on complying with the regulatory framework and/or licensing requirements. ([World Bank 2020](#))

M

MACROPRUDENTIAL SUPERVISION

Supervision that considers the interactions among individual financial institutions, as well as the feedback loops of the financial sector with the real economy, including the costs that systemic risk entails in terms of output losses. ([ECB 2014](#))

MARKET INTEGRITY

Concerned with the capacity to pursue the ‘dirty money’ that flows through the global financial system, imposing a significant cost on national security, economic opportunity, and the rule of law. It is also connected with regulators’ ability to uncover, prosecute, and prevent such movements in the future, as well as to restore official funds stolen in corruption to public coffers. ([World Bank 2022](#))

MICROPRUDENTIAL SUPERVISION

Supervision that focuses on safeguarding individual financial institutions from idiosyncratic risks and preventing them from taking too much risk. ([ECB 2014](#))

MOBILE MONEY

Monetary value that is: i) available to a user to conduct transactions through a mobile device; ii) accepted as a means of payment by parties other than the issuer; iii) issued on receipt of funds in an amount equal to the available monetary value; iv) electronically recorded; v) mirrored by the value stored in an account(s) usually open in one (or more) bank(s); and vi) redeemable for cash. In jurisdictions where ‘electronic money’ (or ‘e-money’) has been defined in regulation or legislation, mobile money is a form of e-money. ([di Castri 2012](#))

N

NATURAL LANGUAGE PROCESSING (NLP)

An interdisciplinary field of computer science, artificial intelligence, and computation linguistics that focuses on programming computers and algorithms to parse, process, and understand human language. NLP is a form of AI. ([FSB 2020](#))

NETWORK ANALYSIS

The use of quantitative and qualitative data to model and draw insights regarding the formal and less-formal interconnections between a set of related entities, for example, a measure of the degree to which a financial system will be weakened by the cascading transmission of financial distress across institutions. ([IMF 2010](#))



OPTICAL CHARACTER RECOGNITION (OCR)

A specific form of computer vision that focuses on transcribing image data into textual data. Examples include license plate readers, OCR-enabled scanners and mobile apps, passport and other identification card readers, and file conversion tools. ([R²A 2017](#))



PREDICTIVE ANALYTICS TOOLS

The advanced analysis of historical data to create statistical models to predict future events, values, facts or characteristics. This process may include recommendation engines (tools where the prediction is an optimal value or action) and employ machine learning (computerised, iterative optimisation of the aforementioned statistical models). ([TechTarget 2022](#))



REGTECH

An acronym for 'regulatory technology'. It involves new technologies to help regulated financial service providers streamline audit, compliance and risk management and other back-office functions to enhance productivity and overcome regulatory challenges, such as the risks and costs related to regulatory reporting and compliance obligations. This can also refer to firms that offer such applications. ([World Bank 2020](#))

ROBOTIC PROCESS AUTOMATION (RPA)

The automation of the basic tasks defined by a user; these tasks can include filling forms and checking forms for completeness. ([TechTarget 2022](#))



SUPTECH

An acronym for 'supervisory technology'. It is the application of technology and data analysis solutions to complement and enhance a financial authority's financial market oversight capabilities. Suptech applications are used by financial authorities to access more granular, diverse, timely and trustworthy data to improve operational efficiency and generate previously unattainable insights, thus improving decision-making. ([Cambridge SupTech Lab 2022](#))

SENTIMENT ANALYSIS

A specific form of natural language processing that focuses on inferring the emotional content expressed in a given corpus of text or transcribed speech. Examples include social media data mining to understand public sentiment surrounding a given topic or entity and analysing customer service requests/complaints to inform escalation. ([R²A, 2017](#))

T

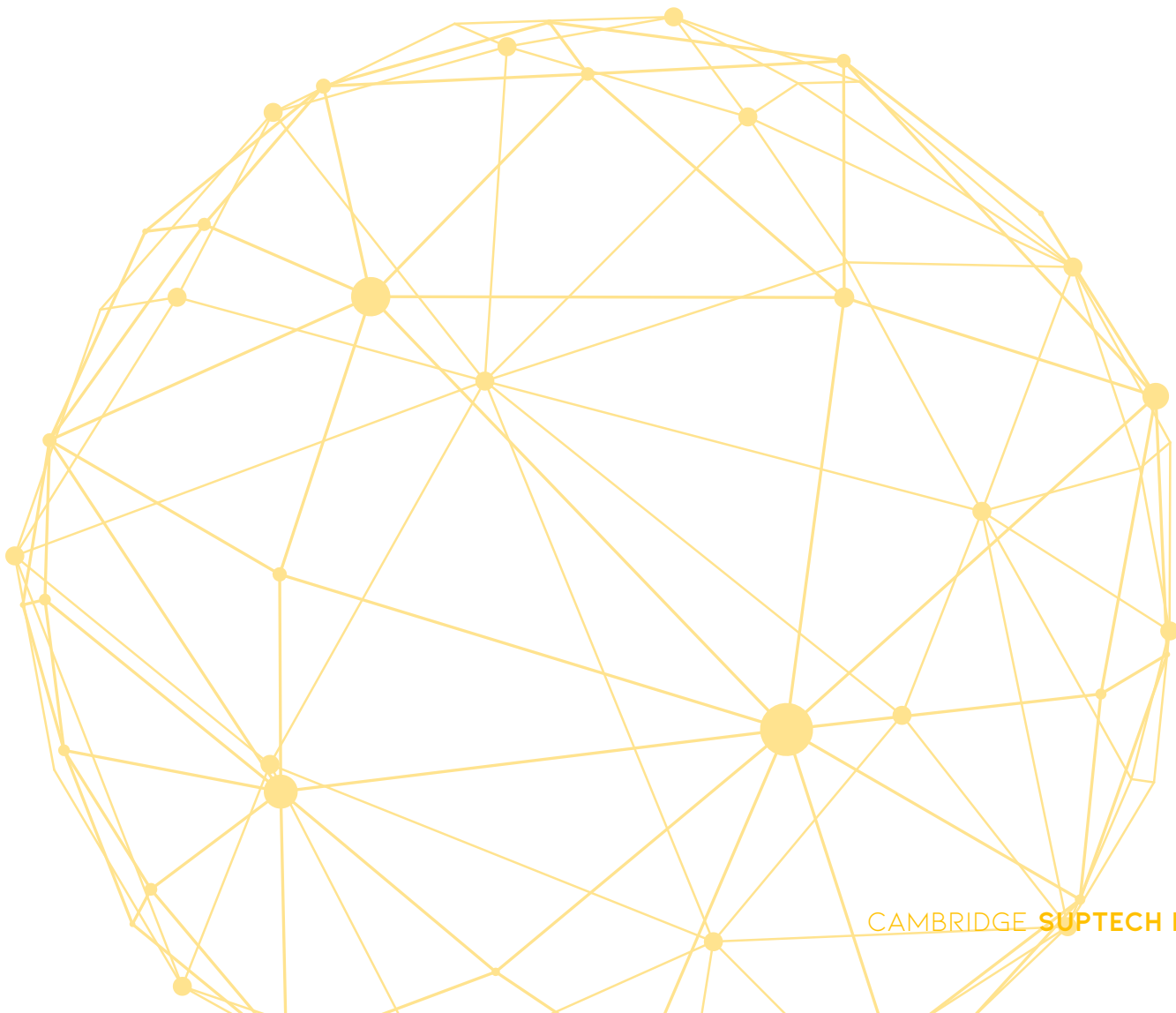
TEXT MINING

The process of discovering interesting and useful patterns and relationships in large volumes of text. This process uses tools from statistics and artificial intelligence. ([IBM 2022](#))

W

WEB SCRAPING

The process of using software to extract data from websites. ([Cambridge SupTech Lab 2022](#))



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