A Roadmap to SupTech Solutions for Low Income (IDA) Countries

FINANCE, COMPETITIVENESS & INNOVATION GLOBAL PRACTICE

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Table of Contents

Acknowledgments V

Abbreviations and Acronyms VII

Glossary IX

1. Executive Summary 1
   - Methodology 2
   - Structure 3
   - Purpose and Intended Audience of the Paper 3

2. Supervision Cycle 5

3. Challenges for International Development Association (IDA) Countries 7
   - Data Quality 7
   - Capacity and Resources 8
   - Integrity 9
   - Analytical Tools 9

4. Classification of SupTech Use Cases 13
   - Use Case 1: Automated Data Reporting (ADR) 15
   - Use Case 2: Credit Risk Assessment 16
   - Use Case 3: Workflow Management 17

5. SupTech Strategy and Decision Making 19
   - Approaches for Applying SupTech Solutions 19
   - Obstacles to the Implementation of SupTech Solutions 20
   - Design of SupTech Strategy 20
   - Implementation of SupTech Strategy 23

6. Conclusion 27

Annex 1. SupTech Tool Classification 29

Annex 2. Reference Guide for SupTech Project Implementation 35

Endnotes 43

LIST OF BOXES

Box 1. Can SupTech Solutions be Useful for FCV Countries 11
Box 2. Risks of SupTech Solutions 14

LIST OF FIGURES

Figure 1. Key Supervisory Processes 5
Figure 2. Tools to Support an Effective RBS Framework 6
Figure 3. Results of BCP Assessments Conducted in IDA Countries 7
Figure 4. Geographic Spread of IDA Countries 9
Figure 5. Mapping of SupTech Use Cases to Supervision Phases 13
Figure 6. Typical Components of an ADR System 15
Figure 7. General Approaches Towards Applying a SupTech Solution 19
Figure 8. Steps Toward Defining a SupTech Strategy 22
Figure 9. Core Elements of a Detailed SupTech Roadmap Implementation Plan 24

LIST OF TABLES

Table 1. Obstacles to the Adoption of SupTech Faced by IDA Countries, and Potential Remedies 21
Table 2. Common Success and Risk Factors for the Implementation of SupTech Solutions 21
Table 3. Analysis Criteria to Determine Supervisors' Readiness (Sample) 23

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SupTech
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Abbreviations and Acronyms

AI	Artificial Intelligence
ADR	Automated Data Reporting
AI	Artificial Intelligence
AML/CFT	Anti-money laundering/combating the financing of terrorism
API	Application programming interface
APRA	Australian Prudential Regulation Authority
ASIC	Australian Securities and Investment Commission
AUSTRAC	Australian Transaction Reports and Analysis Centre
BaFin	Federal Financial Supervisory Authority (Germany)
Banxico	Bank of Mexico
BCBS	Basel Committee on Banking Supervision
BCP	Basel Core Principles
BI	Business Intelligence
BIS	Bank for International Settlements
BNM	Central Bank of Malaysia
BNR	National Bank of Rwanda
BoE	Bank of England
BoG	Bank of Greece
BoI	Bank of Italy
BoP	Bank of Portugal
BOT	Bank of Thailand
BSP	Bangko Sentral ng Pilipinas
CBN	Central Bank of Nigeria
CBR	Central Bank of Russia
CNBV	Mexico's National Banking and Securities Commission
CP	Core Principle
CPIA	Country Policy and Institutional Assessment
DB	Deutsche Bundesbank
DFSA	Dubai Financial Services Authority
DNB	De Nederlandsche Bank
DNFBP	Designated Non-Financial Business and Professions
DT&DI	Digital transformation and data-driven innovation

EBA	European Banking Authority
ECB	European Central Bank
EDW	Electronic Data Warehouse
ERP	Enterprise resource planning
ESMA	European Securities and Markets Authority
FATF	Financial Action Task Force
FCA	Financial Conduct Authority
FCV	Fragile, Conflict and Violence
FED	US Federal Reserve
FI	Financial Institutions
FIC	Financial Intelligence Centre of South Africa
FinTech	Financial technology
FINTRAC	Financial Transactions and Reports Analysis Centre of Canada
FSAP	Financial Sector Assessment Program
FSB	Financial Stability Board
FSS SK	Financial Supervisory Service (South Korea)
GFC	Global financial crises
GIS	Geographic Information System
GNI	Gross national income
HKMA	Hong Kong Monetary Authority
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IFRS	International Financial Reporting Standards
IT	Information technology
MAS	Monetary Authority of Singapore
ML	Machine Learning
NLP	Natural language processing
NRB	Nepal Rastra Bank
OeNB	Austrian National Bank
PRA	Prudential Regulation Authority (UK)
RAP	Financial Intelligence Unit of Finland
RBA	Risk based approach
RBI	Reserve Bank of India
RBS	Risk-Based Supervision
RIS	Regulatory Information & Workflows System
ROSFIN	Financial Intelligence Unit of Russia
SBP	State Bank of Pakistan
SEC	U.S. Securities and Exchange Commission
SSB	Standard-Setting bodies
SupTech	Supervisory technology
UIF	Financial Intelligence Unit of Italy
UN	United Nations
VASP	Virtual asset service providers
WB	World Bank

Glossary

Risk based supervision: a structured process that identifies the most critical risks faced by an individual bank as well as systemic risks in the financial system.[1]

SupTech: use of technology to facilitate and enhance supervisory processes from the perspective of supervisory authorities.[2]

RegTech: management of regulatory processes within the financial industry through technology.[3]

FinTech: 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.[4]

Application programming interfaces (APIs): a set of rules and specifications that software programs use to communicate with each other, and an interface between different software programs that facilitates this interaction.

Automated Data Reporting (ADR): technology-driven solutions involving automatic gathering of data from different platforms and integrating of such data into the software's system.

Artificial intelligence (AI): IT systems that can perform functions that would otherwise require human capabilities, e.g. discover and test hypotheses, make decisions, etc.

Big Data: a field that treats ways to analyze, systematically extract information from, or otherwise deal with data sets that are too large or complex to be dealt with by traditional data-processing application software.

Cloud computing: use of an online network ("cloud") of hosting processors to increase the scale and flexibility of computing capacity.

Data push approach: reporting framework in which supervised entities "push" data to a supervisory agency. The supervised entities prepare their data in a standard format in a series of basic datacubes as prescribed by the supervisory agency. The basic datacubes are uploaded to the supervisory agency and then transformed into a series of smart datacubes formatted to the agency's requirements.

Data pull approach: a reporting framework in which supervisory agencies "pull" data directly from the IT systems of supervised entities.

Electronic Data Warehouse: central repositories of integrated data from one or more disparate sources.

Machine learning (ML): a method of designing problem-solving rules that improve automatically through experience.

Natural language processing (NLP): the capacity of computer programs to process human language.

Regulatory Information & Workflows System (RIS): technology-driven solutions involving an integrated suite of automated workflows, specific methodologies, analytical tools and reporting capabilities.

1.

Executive Summary

Even before the COVID-19 crisis, the world was witnessing significant transformations in financial sector supervision. These transformations — a number of which occurred after the 2008 Global Financial Crisis (GFC) — have been driven by two main factors. The first factor was the changes in the market that resulted in changing business models and ensuing risk profiles in the financial sector, which in turn led to adjustments and increases in supervision. The second factor was the increasingly widespread availability of technologies, computing power and data that can facilitate and support supervision processes.

The COVID-19 pandemic is a third factor that will likely drive further transformation in financial sector supervision. The pandemic created a new urgency for supervision and oversight to be able to be conducted remotely, as lockdowns and travel restrictions have required people to work from home for indefinite periods of time. Furthermore, the economic devastation caused by the pandemic has increased pressure on supervisors to react faster, requiring tailored policy decisions to stabilize the financial sector and protect depositors.

A number of key technologies that can support supervision, such as Big Data, Artificial Intelligence, Machine learning or even Blockchain, were developed some years ago. However, these technologies have remained largely out of reach in developing and low-income countries, either due to high costs or lack of computing power. In recent years, though, costs for collection, validation, storage, processing and disseminating of data has decreased drastically, resulting in a number of technologies becoming accessible, and opening a new chapter in the advent of supervision — this is referred to as 'Supervisory Technology' or 'SupTech'.

The term SupTech does not have a universally accepted definition. However, for the purposes of this paper, we have drawn on the definition of SupTech from the Basel Committee on Banking Supervision (BCBS)[6] to define SupTech as the use of technology to facilitate and enhance supervisory processes from the perspective of supervisory authorities.[7]

Early experience from developed and developing countries has shown substantial potential for the use of SupTech solutions to enhance supervision. The United Kingdom's Financial Conduct Authority (FCA), the Bank of Mexico (Banxico), the Dutch Central Bank (DNB) and the Bank of Italy (BoI) are just a few of the

supervisory authorities that have demonstrated how useful SupTech can be (fuller list is available in Annex 1). SupTech can help supervisory authorities process information faster and in larger quantities, automate and streamline processes, and identify trends and analyze key risks, among other features. The end result is more efficient decision-making, a move towards predictive supervision and risk identification as well as increased ability to achieve regulatory objectives of financial stability and integrity.

How will these SupTech solutions work in lower income (International Development Association - IDA[8]) countries where resources and infrastructure are limited? To answer this question, the paper explores the main supervisory challenges in IDA countries, particularly in relation to resource and capacity needs. Cases of the use of SupTech tools in a number of jurisdictions are presented, along with learnings derived from those experiences. A detailed roadmap is provided, including critical issues to be addressed along the path to effective implementation of SupTech tools. The intention is to support policymakers in their decision-making process as they embark on their SupTech journey.

According to the Financial Sector Assessment Program (FSAP) reports (see Methodology section for more detail), financial sector supervision in most IDA countries is still weak, preventing supervisors from effectively and efficiently implementing international standards and best practices. Major challenges faced by supervisors in these jurisdictions include low quality of data, limited resources, lack of technical expertise, and weak IT infrastructure. The current COVID-19 pandemic introduced additional challenges to supervision; it has become more difficult to maintain financial stability and ensure adequate risk mitigation in the context of the changes occurring in financial institutions in response to social distancing measures and deteriorating portfolio quality. Thus far, use of SupTech tools in IDA countries has been minimal, which has limited supervisors from effectively addressing existing and new supervision challenges.

The specific focus of this paper is on SupTech solutions employed in prudential and Anti-money laundering/ combating the financing of terrorism (AML/CFT) use cases to support the implementation of effective Risk-Based Supervision (RBS).[9] RBS is a market and firm level supervision strategy that allocates priority and resources in accordance with the risk each Financial Institution (FI) poses to the financial system. The RBS approach has been propelled by the standard-setting bodies (SSBs) and has become the dominant method of supervision in recent years.

As the scope and mandate of supervisory authorities expands (in part due to significant tightening of international standards by the standard-setting bodies (e.g. Basel III, IFRS-9), leading to increased responsibilities and more data being collected), there will come a time where leveraging technology is a necessity. The swiftly increasing complexity of the operations conducted by FIs has posed a major challenge to the implementation of RBS; it has become very complicated to identify and assess the risks associated with each FI, and to ensure that the assessments are up to date. There is a need to identify risks in real-time and act quickly, which requires delving deeper into the ever-larger pool of reported data (technically referred to as Big Data, due to its size and complexity).

The future of supervision lies in bringing technological advancements to support and streamline processes and increase the quality of supervision. This paper identifies the SupTech tools used to support each stage of the supervisory process, from macroeconomic assessments through to licensing, supervision and enforcement of FIs, with the aim of highlighting smart uses of technology in IDA countries to support prudential and AML/CFT regulation. Specifically, the paper highlights three use cases – in data reporting, risk assessment and process automation – that were identified as especially relevant for IDA countries. It also outlines the main facets of a strategic roadmap, along with governance and implementation approaches that are particularly suitable for IDA countries keen to realize SupTech efficiencies.

Methodology

This paper is based on a number of inputs, including: interviews with supervisory authorities, desk-based research and literature reviews, analysis of Financial Sector Assessment Programs (FSAPs)[10] and Mutual

Evaluations by the Financial Action Task Force (FATF), and a survey of WBG project teams working in IDA countries. To identify supervisory challenges in IDA countries, three main sources of information were used: (i) assessments of compliance with Core Principles for Effective Banking Supervision (BCP)[11] conducted during the Financial Sector Assessment Program (FSAP) for the period of 2009-2019; (ii) Mutual Evaluations[12] (particularly, "Immediate Outcome 3") conducted by FATF during the period of 2015-2020 [13]; and (iii) survey on major supervisory challenges in IDA countries answered by WBG project leaders in the area of bank supervision in IDA countries.

For identification and analysis of SupTech use cases as well as preparation of SupTech project implementation guidelines, the following sources of information were used: (i) desk-based research and literature review, including relevant research on SupTech tools by BIS, EBA, FSB, ESMA, among others; and (ii) interviews with Standard-Setting Bodies (SSBs), Central Banks, and regulators. While this paper probes in some depth into implications for prudential supervision and AML/CFT in IDA countries, it does not aim to provide a comprehensive overview and understanding of all emerging SupTech solutions. Instead, it sketches a roadmap and areas for consideration for adopting SupTech solutions that support the transition to a Risk-Based Supervisory approach by highlighting best practices in advanced economies that could be relevant to IDA countries.

The paper includes in the Annexes a compendium of the SupTech solutions implemented by supervisory authorities all around the world linked to specific supervision phases, to help national authorities to identify the areas of supervision that can be supported.

Structure

Recognizing the importance of effective prudential and AML/CFT supervision in IDA countries, particularly during episodes such as the financial crisis and COVID-19 pandemic, the paper is developed as follows: Section 2 provides an overview of the supervision cycle, detailing the key supervisory activities and the benefits of Risk-Based Supervision. The challenges faced by IDA countries are expounded upon in Section 3. Section 4 delineates the concrete examples of SupTech use cases implemented in a range of jurisdictions and classifies them based on their underlying application to the supervision lifecycle. It is an analysis of the various SupTech tools, followed by a more detailed description of the use cases suitable to the IDA context. Section 5 covers key issues regarding the decision-making processes on SupTech strategy, and provides some recommendations and guidelines when considering engaging in a SupTech implementation project.

Purpose and Intended Audience of the Paper

This is a guide for policymakers and decision makers who are considering launching a SupTech pilot, project or strategy. While some technical detail is included, the paper is primarily intended for those who will be taking and making decisions and is not intended as a technical guide that outlines all the tools available.


SupTech
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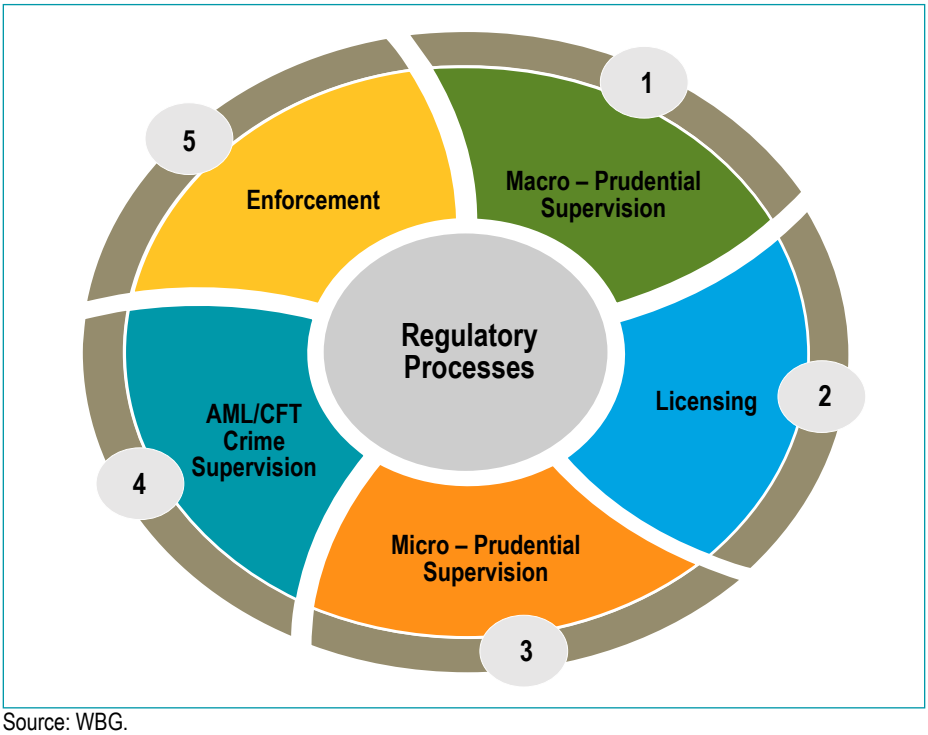
2. Supervision Cycle

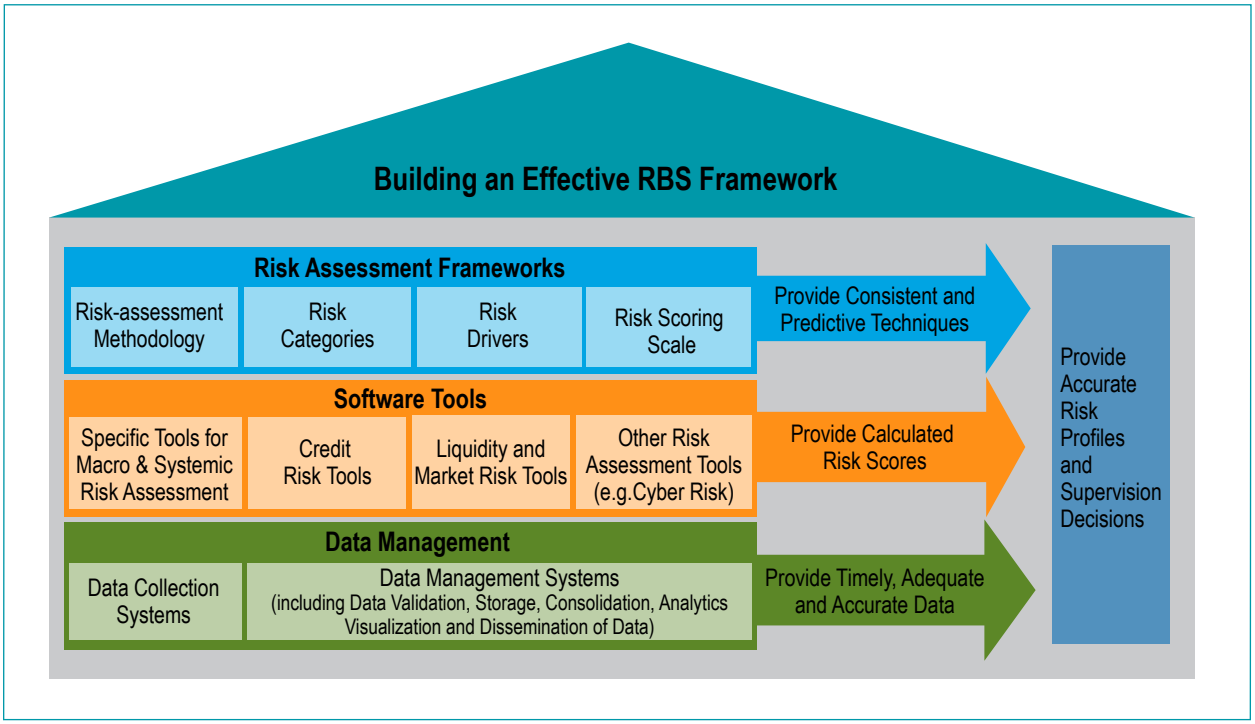
Risk-Based Supervision (RBS) is gradually becoming the dominant approach to regulatory supervision of financial institutions around the world. It is a structured system that assesses risks posed by a regulated financial institution and prioritizes allocation of supervisory resources in proportion to these risks. The supervision of the licensed entities is performed at two levels, micro-prudential supervision focusing on firms and the macro-prudential supervision addressing the wider system and financial markets as a whole. Most supervisors employ the RBS approach to organize and execute their key activities, namely licensing, micro-prudential (firm-level) supervision, AML/CFT or financial crime supervision, conduct supervision, and macro-prudential supervision (figure 1 below).

Figure 1. Key Supervisory Processes



Source: WBG.

Figure 2. Tools to Support an Effective RBS Framework



Source: WBG.

With the RBS system, entities are monitored both for compliance with regulations as well as their risk management and ability to stay within the regulator's pre-defined risk tolerance. Various facets of the RBS process are supported by data and the ability to draw meaning from the data. As the quantities of data around the world increase, SupTech tools can support regulators in analyzing the data, not only bringing about more efficiencies and streamlining the process but potentially identifying trends and outliers that might have been missed previously.

The diagram above illustrates the essential features of an effective RBS framework. Starting from the foundational level, the effectiveness of the RBS framework relies on timely, adequate and accurate data management, covering various facets of financial institutions' data as well as relevant macro data about the markets and the economy. This requires: i) an efficient and user-friendly data collection system- for both internal and external data, and ii) a comprehensive data management function covering systems for data validation, storage, consolidation, analytics visualization and dissemination that can potentially work with both structured and unstructured data. Data is fed into software tools that support a credible risk assessment framework, enabling supervisors to produce accurate risk profiles of financial institutions they supervise. The core components of such a risk assessment framework include risk categories, underlying drivers, risk tolerance and a calibrated risk scoring scale which will define a risk profile for each institution under supervision. These risk profiles, are used as the basis for any supervisory actions and for allocation of supervisory resources, in the context of a stated risk tolerance.

Data, and specifically the ability to aggregate and analyze large sets of it, has fueled the growth of SupTech solutions and their potential to support RBS. Modern approaches to regulation are built around Big Data[14] and the ability for tools such as Artificial Intelligence (AI) and Machine Learning (ML) to make sense of it. Understanding the various key activities of a supervisor and the critical tools employed provides a useful backdrop to assess the suitability, effectiveness and impact of various SupTech uses. However, while SupTech has the potential to support many aspects of the supervisory process, this paper focuses primarily on prudential supervision and AML/CFT supervision.

3. Challenges for International Development Association (IDA) Countries

In order to understand how SupTech tools can support the enhancement of the supervision of financial institutions in IDA countries, there is a need to identify and analyze the main challenges faced by supervisors in these countries. Although most of the challenges identified in IDA countries are also common in other jurisdictions, the intensity of these challenges is much higher in IDA countries and the solutions available to address them effectively are more limited. Below is a discussion of some of the main challenges that have been identified for IDA countries, along with ideas of how the challenges can potentially be solved through the use of SupTech tools.

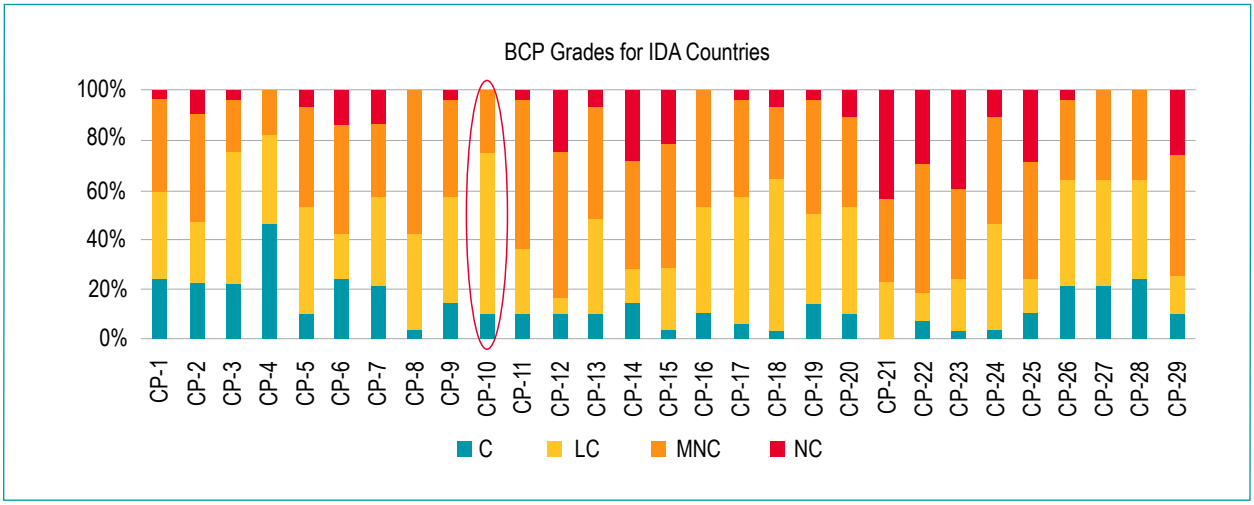
Data Quality

Out of 28 Basel Core Principles (BCP) assessments analyzed that were conducted in IDA countries, only three countries received a "Compliant" grade for Principle 10: "Supervisory reporting" (Figure 3). This indicates that IDA countries face significant challenges in gathering timely and sufficiently granular information for prudential supervisory purposes. The quality of data was also indicated by World Bank country project leads as a primary area that could potentially be enhanced by the use of SupTech solutions. This problem has a cascade effect on many other BCP Principles[15]; the inability of the supervisory authorities to ensure adequate quality and depth of data reporting jeopardizes their ability to effectively identify and assess risks (credit, liquidity, concentration, other), and makes it almost impossible to transition to an effective RBS regime.

To identify how the data quality challenge can be overcome with the support of SupTech solutions, there is a need to look at the underlying elements of the reporting framework. Key elements of the reporting framework include: the reporting rules & guidance put forth by the regulator that the supervised entity needs to comply with[17]; the data collection process, such as a push (from the regulated entity) or pull (from the regulator) (See Use Case 1 below); and the reporting system, which includes the data validation and metrics used by supervisors (See Use Case 2).

The use of SupTech tools in the reporting framework can help to identify deficiencies at the level of prudential requirements, including redundant information and incomplete information, as well as to formulate recommendations for enhancing data collection processes at the level of supervised entities, thereby supporting the collection of better quality data.

Figure 3. Results of BCP Assessments Conducted in IDA Countries[16]



Legend: C = compliant, LC = largely compliant, MNC = materially non-compliant, NC = non-compliant.
Note: CP = Compliant Principle. Principle 1: Responsibilities, objectives and powers; Principle 2: Independence, accountability, resourcing and legal protection for supervisors. Principle 3: Cooperation and collaboration. Principle 4: Permissible activities. Principle 5: Licensing criteria. Principle 6: Transfer of significant ownership. Principle 7: Major acquisitions. Principle 8: Supervisory approach. Principle 9: Supervisory techniques and tools. Principle 10: Supervisory reporting. Principle 11: Corrective and sanctioning powers of supervisors. Principle 12: Consolidated supervision. Principle 13: Home-host relationships. Principle 14: Corporate governance. Principle 15: Risk management process. Principle 16: Capital adequacy. Principle 17: Credit risk. Principle 18: Problem assets, provisions and reserves. Principle 19: Concentration risk and large exposure limits. Principle 20: Transactions with related parties. Principle 21: Country and transfer risks. Principle 22: Market risk3. Principle 23: Interest rate risk in the banking book. Principle 24: Liquidity risk. Principle 25: Operational risk. Principle 26: Internal control and audit. Principle 27: Financial reporting and external audit. Principle 28: Disclosure and transparency. Principle 29: Abuse of financial services.

Capacity and Resources

Capacity of the supervisory authority was identified as a key challenge both by World Bank project leads as well the formal BCP assessments. More than half of the assessed IDA countries received a Materially Non-Compliant or Non-Compliant grade for Principle 2: "Independence, accountability, resourcing and legal protection for supervisors" (Figure 3). There could be varied reasons for this, one of the most common being the limited financial resources: many IDA countries are faced with significant restrictions on the availability of financial resources for public authorities. This is due to constant macroeconomic and fiscal challenges, such as high public deficit and indebtedness, inflation, and depreciation of national currency. In such situations, even if the supervisory authorities have a mandate allowing financial autonomy, it is often very difficult for the supervisors to access the required financial resources.

Another issue is compensation: the remuneration of the supervisory authorities is generally lower than that of comparable positions in the private sector, making the hiring and retention of talent challenging. High staff turnover detracts from the value of long-term training programs for staff, while limited resources impacts the ability of supervisors to participate in trainings organized by regional or international organizations (represent an important opportunity for capacity building). Resources also impact the number of staff allocated to each financial institution, which in turn influences the speed and breadth of supervisory activities that can be undertaken. The combined effect is that the capacity of the supervisors in IDA countries to identify, assess and mitigate the risks in financial sector is often significantly lower than that of supervisors in developed countries.

The capacity of supervisory authorities has been further affected by the COVID-19 crisis, disrupting supervisory processes and increasing the need to conduct off-site inspections (as on-site inspections have become impossible), and increasing demand to monitor risks in real-time. The pandemic is impacting

the macroeconomic and fiscal stability of all countries, with severe consequences expected in IDA countries. Thus, the gap between the expectations of supervisory authorities in IDA countries and their capacity to meet those expectations is likely to continue to grow during the pandemic.

Increasing the capacity of the supervisory authorities in IDA countries by increasing headcount is likely to be a long and arduous process that would require support from international organizations, including the World Bank Group. The challenges of doing so drive the need to develop alternative solutions to compensate for the insufficient number of staff in the supervisory authorities. With proper design and implementation, SupTech tools can help supervisory authorities fulfill their obligations with reallocation of staff to focus on essential activities, supplemented by innovative methods of supervision.

Integrity

In IDA countries the effectiveness of AML/CFT supervision is potentially even lower than that of prudential supervision, according to the information disclosed by FATF . All IDA countries received either a "Moderate level of effectiveness" or "Low level of effectiveness" rating on FATF "Immediate Outcome 3", which assesses whether 'supervisors execute their supervision function appropriately, monitor and regulate financial institutions, Designated Non-Financial Business and Professions (DNFBPs) and Virtual asset service providers (VASPs) for compliance with AML/CFT requirements commensurate with their risks'(Figure 4). This indicates a significant need for improvement of the supervisory effectiveness. The automation of systems and use of SupTech tools can be a mitigant against integrity issues and political interference, and improve the independence of the supervision function.

Analytical Tools

The amount and granularity of information collected by supervisory authorities grows constantly as a result of increasing complexity of products and services, such as Fintech, offered by the financial sector and the identification of new risk factors. Moreover, market changes such as the 2008 Global financial crises (GFC) led to an increase in data requested by supervisory

Figure 4. Geographic Spread of IDA Countries

Source: WBG, FATF.
Note: All IDA countries under assessment received a Moderate (Yellow) or Low (Red) Level of Effectiveness for Immediate Outcome 3.

authorities. Developed markets experienced a almost a 5 fold increase in regulatory changes between 2008 and 2015 as a result of the GFC, according to a study done in 2017.[18] The GFC made it clear that there was a need for more intensive regulation and assessment of risks. We are likely going to see another increase in data requests from supervisors due to the global COVID-19 pandemic. This increase in the amount of data collected has put significant pressure on supervisors to find ways to analyze the collected information in a timely fashion and quickly identify remedial or recovery measures, as necessary. However, the amount of information collected greatly exceeds the capacity of supervisors to process and analyze it manually even in developed countries. In fact, the data collected has reached such level of detail, volume and complexity that it is often referred to as 'Big Data'. The use of analytical SupTech solutions is essential, particularly considering the significant share of unstructured information (e-mail, letters, reports, internal procedures, news, management information including board reports and other sources) collected by supervisors. SupTech tools involving artificial intelligence/machine learning (AI/ML) support the critical risk identification process through the analysis of Big Data, bolstering the analytical capacity of the supervisory authority and subsequently supporting the implementation of RBS .

According to the information collected from the World Bank project leads, and confirmed by FSAP findings, there is a significant gap in the analytical capacity of IDA countries. Furthermore, the use of analytical tools to process the collected information from supervised entities is limited in IDA countries. There are a number of reasons for this, among which the most important include:

- **High price of modern business analytical tools.** For many IDA countries, the cost is prohibitive to obtain modern analytical tools, such as Business Intelligence (BI) tools that analyze large quantities of information and present it as actionable information that can guide decision making.. The cost of such tools may represent a significant part of a supervisory authority's budget earmarked for development, thus making it difficult to get the necessary large budgetary allocations for this type of tools, although over the long term such investments may lead to substantial savings for a supervisory authority.
- **Lack of knowledge and expertise in using modern analytical tools.** The availability of supervisors in IDA countries with certifications in data analytics or expertise in using BI tools is limited. However, with a proper training program in place and active participation of the supervisor in the process of implementation of analytical tools, there is a real possibility to increase the knowledge and expertise in a relatively short period of time.
- **Underdeveloped IT infrastructure.** Use of the modern analytical tools requires that at least a minimum level of IT infrastructure be in place. Unfortunately, due to lack of funds, the existing IT infrastructure in many IDA countries requires significant upgrading, before starting to implement modern analytical tools.

It should be noted that analyzing unstructured data doesn't require a well-structured data warehouse, so there may be significant opportunity for IDA countries to benefit from unstructured data analysis. The use of analytical tools for processing unstructured information started significantly later compared with the tools used for structured information, but technological developments in recent years (cloud computing, artificial intelligence, and machine learning, for example) have made the tools for processing and analyzing unstructured data accessible, presenting an opportunity for the streamlining of supervisory processes, as much of the information collected in the process of supervision is unstructured information.

Data Collection: The effective collection of information from supervised entities represents the first step in the complex process of the implementation of RBS (See Use Case 1). Unfortunately, the process of data collection in IDA countries is characterized by significant fragmentation in the reporting process. It is common to see multiple channels of reporting, including via e-mail and on paper. Also, quite often, there is no one single contact point for the reporting process at the level of supervisory authority. This makes it very difficult to create and maintain a functionable data warehouse, which is necessary for the data analysis process.

Though the right process of collecting granular and high quality prudential / financial information from the reporting entities is essential, unless the data collected is subject to thorough analysis, supervisors will be unable to effectively identify and assess risks. Markets such as the UK have started considering the use of a machine-readable rule book, that will automatically execute a regulatory requirement, effectively pulling the required information directly from the firm.[20]

Internal and cross-agency communication and documentation: Effective supervision is not only based on the interaction of the supervisor with the supervised entities. Proper lines of communication between staff involved in the different components of the supervision process also play a critical role in ensuring effective supervision. In countries where more than one supervisory authority is involved in supervision of the financial sector, effective cross-agency communication is also essential. Information is garnered through many components of the supervision process: macro-prudential supervision, micro-prudential supervision, on-site, off-site, supervision of small, medium and large banks. Staff involved in all of these components of the supervision process should be able to easily share information and communicate freely and effectively with each other to ensure a common understanding of risks at the individual bank level as well at the system level.

Unfortunately, communication between these supervisory components is often deficient, although this problem is not peculiar to IDA countries. It is not unusual to see that on-site supervision is not coordinated with off-site supervision, or that macro-prudential supervision is not communicating about systemic risks to micro-prudential supervision. Contributing to this lack of coordination are: i) fragmentated workflow processes and ii) the lack of a single database containing assessments, identified risks, measures taken, and remedial activities. This dissonance in the activity of the supervisory authority is particularly problematic during times of crisis, when speed and quality of decisions are especially critical.

SupTech tools cannot resolve all the underlying factors contributing to communication problems among supervisory authorities, but the tools can facilitate the sharing of information through automation and data sharing. (See Use Case 3) Two problems in particular can be addressed by technological advances: i) insufficient human resources, meaning that an already overburdened staff has no time available to devote to effective communication between different components of the supervision process, and ii) lack of IT tools to ensure an effective workflow in the supervisory processes, documentation of findings and sharing of information. The significant pressure on human resources leads staff in each component of the supervision process to focus only on their direct objectives, and to lack time to consider ways in which information may be useful to other teams involved in supervision. Without SupTech tools to automate the sharing of information, teams are left operating in silos, which can have a negative cascading effect on the entire supervision process, leading to significant delays in the identification of major risks. Unfortunately, there is a low probability that the number of staff involved in the supervision will be increased up to the level that will permit an effective and continuous internal communication between different components of the supervision process. However, there is a great potential to enhance internal communication by using IT solutions for a range of supervisory actions. These tools can ensure that the information generated by different components of the supervision process will be stored in a centralized database and accessible whenever necessary. Advanced functionalities like case management, predictive analysis, sentiment analysis, and voice to text can facilitate the communication within the supervisory authority; such tools can also alleviate some of the pressure on human resources by eliminating redundant or manual activities related to data collection and dissemination.

Box 1. Can SupTech Solutions be useful for FCV countries

FCV countries are experiencing violent conflict and/or suffering from high levels of institutional and social fragility[21]; they may face deep institutional crises, have poor transparency and government accountability, or have weak institutional capacity. The financial sector of FCV countries tends to be immature, lagging behind the rest of the world in terms of financial depth, access, and efficiency; FCV countries are generally ranked below low-income countries in terms of financial sector development as suggested by the IMF FDI Index. Compared to low-income countries (Section 3), FCV countries often face even greater challenges in banking supervision, such as poor data quality, insufficient financial resources, low analytical capacity, and scarce human and IT resources, magnified by weak institutional structures and poor legal and regulatory frameworks. While some FCV countries lack the foundation for a basic level of supervision and need to overcome a number of obstacles before they can start efficiently using technologies in supervision (Section 4), other FCV countries might be able to use SupTech solutions to build up the foundation for efficient and effective supervision in the following areas:

- Data collection and validation: Transitioning from manual to automated data collection yields several benefits: reduces human errors; builds up databases needed for performing analytical work; and enables scarce human resources to be reallocated to more judgement-based work.
- Automation of processes: Going from paper-based to technology-based workflows could ultimately alleviate problems arising from a lack of resources, in that automation of work reduces employee time and frees up financial and human resources over the long term, while also improving institutional capacity for conducting supervision.
- Improved data analytics, including credit risk assessment: Going from spreadsheets to more advanced analytical tools allows for faster and more precise identification of risks along with well-targeted policy design and implementation.

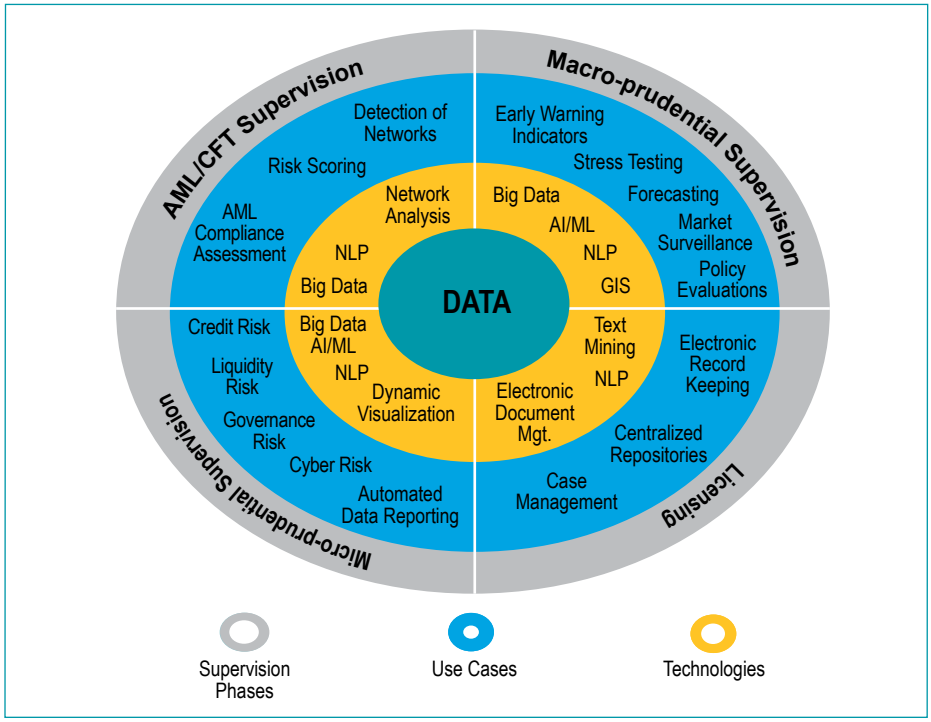
While the roadmap and solutions put forward in this paper can be relevant for some FCV countries, for countries faced with violent conflict or facing an acute lack of basic infrastructure (such as electricity, stable internet connection, and widespread use of IT infrastructure) consideration and implementation of SupTech solutions may be neither possible nor appropriate at the given time.

4. Classification of SupTech Use Cases

This chapter aims to create a broad classification that delineates the various types of cases for which SupTech tools are used. SupTech use cases were considered in a range of economies both developed and emerging; and studied at various stages of implementation, from conceptual to successfully operating.

Figure 5 illustrates how SupTech use cases map to the supervision phases they impact and the different technologies they rely upon. However, it should be noted that use cases and technologies can be overlapping. The figure clearly illustrates the core of all SupTech is data and data management capabilities, an essential precondition to benefit from the full potential offered by SupTech.

Figure 5. Mapping of SupTech Use Cases to Supervision Phases



Source: World Bank analysis and illustration. Please see Annex 1 for more detail on use cases.

Box 2. Risks of SupTech Solutions

SupTech will undoubtedly find new ways to make the work of regulators more accurate and efficient, however it also brings with it risks and challenges. Some of which are noted below:

Cyber Risk: Cyber-attacks are becoming more prevalent, and the susceptibility of regulators to cyber-attacks is higher as supervisory processes migrate to digital platforms, particularly as different areas become more inter-connected and platforms are opened or shared. The greater use of technology and digital solutions expand the range and number of entry points for cyber-attacks. In this regard, SupTech activities could increase the overall vulnerability of the supervisor to cyber risk.

Black Box Issues: AI/ML can produce highly reliable and sophisticated insights, when the input is valid and the output is tested. However, often AI has a Black Box, in which automated decisions are made through elaborate and sometimes unforeseeable algorithmic interactions. This black box makes it difficult for supervisors to fully comprehend how decisions were made and it not always supportive of optimal decision-making.

Legal Risk: Legal risks including those of data protection, inherent biases in the system, could arise when regulators start to handle ever-larger amounts of sensitive datasets. The issue of accountability is one that is beginning to be considered over the use of SupTech.

Operational Risk: With the move towards digitation and automation, the impact of inadequate or failed internal systems, internal controls, procedures, or policies due to breaches, fraud, or external events can have a much larger impact on the operations of the regulator. Due to the number of interdependencies and interconnected systems, a glitch in one system can have knock-on impacts that might be hard to control.

IT Risk: Regulators may have a number of legacy systems that have often not been updated and might work in silos. Choosing new solutions is made more complicated by the need to ensure that they link appropriately with existing systems and there is no loss of information.

While the majority of the SupTech tools observed support data reporting, other tools that are using sentiment analysis, virtual assistance (such as chat-bots) and those that support risk assessment are fast gaining traction. Annex 1 catalogues in detail the spectrum of SupTech in relation to the supervision phase and its relative risk and impact. Policymakers, practitioners and technical staff can refer to the Annex to help inform decisions on the suitability for their country contexts.

Considering the specific challenges faced by IDA countries, three types of uses of SupTech have been identified as providing the most benefit, taking into consideration constraints and challenges faced by these jurisdictions as outlines in Section IV. Below is a detailed description and analysis of these three uses of SupTech, and adaptations for their use in IDA countries.

Automated Data Reporting (ADR)

Collecting relevant data about regulated entities and the economic environment in which they operate is critical for a supervisor to conduct an effective risk assessment at both micro and macro-prudential levels. Historically, data collection has often been done using standardized reporting templates that were submitted manually; this method required substantial time and human resources on both the side of the regulator and the institution being regulated, leading to inefficiency and at times human error.

Increased regulatory scrutiny in the aftermath of the 2008 recession and the trends we are seeing as a result of the COVID-19 pandemic have resulted in new and expanded reports, templates, and calculations being asked of financial institutions. Moreover, the updating of requirements from SSBs have increased the amount of data collection that is required for risk reporting. This increase has made it even more difficult for IDA countries to keep up with their global peers and conduct accurate risk assessment, putting pressure on the already scarce human, financial and technical resources.

Getting the initial data collection stage "right" in a modified, enhanced approach, in an understandable format that can be analyzed by supervisors, is critical. A new paradigm of 'regulatory big data' is emerging worldwide in which an institution provides its bulk underlying granular data to regulators for their regulatory, risk assessment, and stress testing efforts. Big data is a field that treats ways to analyze or

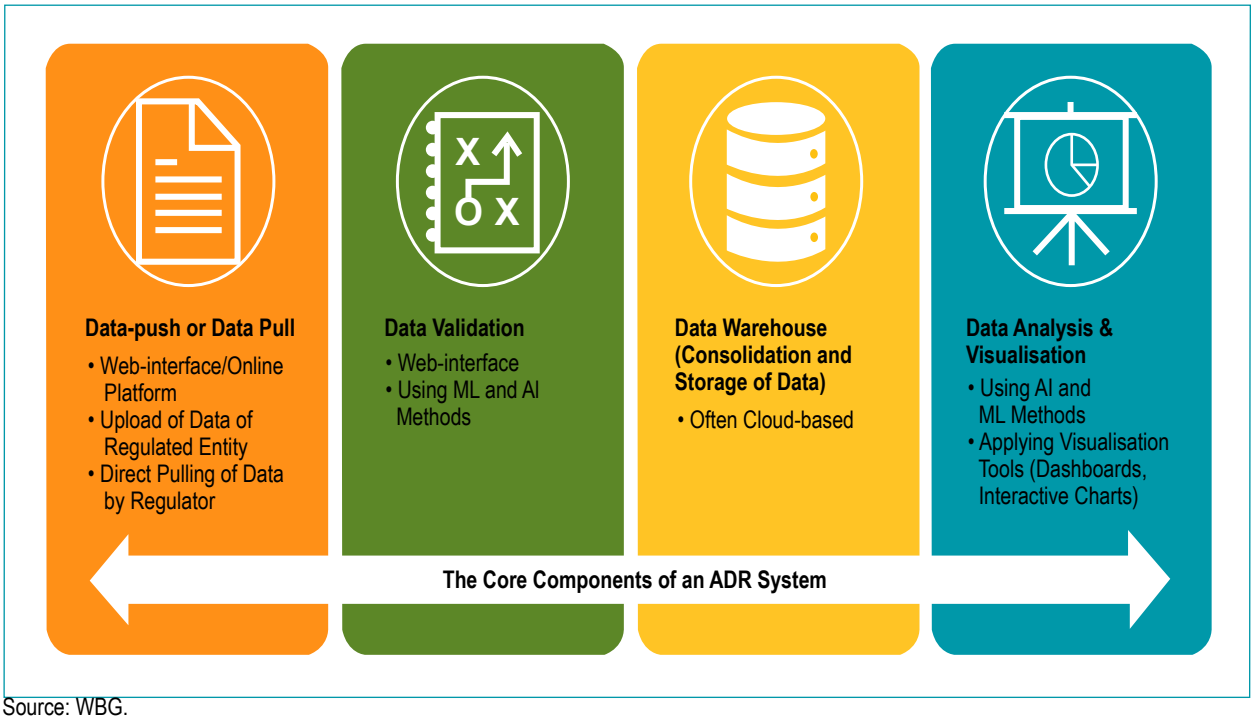
systematically extract information from, data sets that are too large or complex to be dealt with by traditional data-processing application software.

Automated digital applications driven by advanced technologies for data collection have been implemented by many jurisdictions. The results have been positive, including better efficiencies and reduced regulatory burden for regulated entities through the provision of data pull tools by the regulator and submission of data at a granular level that can be used by multiple departments without resubmission. For instance, jurisdictions that have a separate conduct and prudential regulator often require similar information to be submitted to each regulator individually. However, with the use of an ADR system and employing big data processing techniques, as efficiencies can be realized and these duplicative submissions can be avoided. Such applications have been employed in the UAE, Canada, India, Ghana, Nigeria, Oman, Jamaica, Namibia, Philippines, Thailand, Malaysia, UK and, Australia. It should be noted however, that the digital applications utilized in each country vary in scope and spread of technologies employed.

An ADR system can incorporate both quantitative and qualitative data and be available for both periodic and ad-hoc reporting. ADR typically involves a secure web-based interface, simple validation tools for checking the validity of data submitted, and a cloud-based database to store validated data. Reporting tools are also included, bolstered by various technologies (Big Data, AI/ML or Neural Networks), to prepare data for risk analysis or decision-making by a supervisor.

An ADR system can be implemented in a manner suitable to the needs and budgetary constraints of an IDA supervisor. Before implementing a system, it is critical to consider its scalability and ability to interact with existing legacy systems; with the right design features, a new system's scope can be expanded at a later stage based on evolving requirements. A basic system would include the ability to collect, validate and store quantitative data — such as financial or risk data — reported by financial institutions via data-push or data-pull approaches. A more advanced system could potentially include value-add features such as the collection of qualitative data — e.g. management information or even social media information — or

Figure 6. Typical Components of an ADR System



Source: WBG.

ad-hoc data for thematic reviews, while also using advanced analytics and visualization.

Data-push approach. The most common approach is a data-push approach which involves the reporting entity "pushing" the data out from its database automatically, via a platform and into the data collection system employed by the supervisory authority. A basic ADR will involve manual entry of data by the regulated FI into digital forms appearing in an online interface through a secure web portal. For example, the ADR solution employed by Dubai Financial Services Authority (DFSA) has a secure web interface which provides a pre-defined set of forms for every regulated entity according to applicable reporting rules. Each of these forms include a set of pre-defined data elements, populated with formulae according to applicable rules and guidance, that are required to be filled out by the reporting entity manually. Upon submission of the completed forms, the raw data is collected and validated by DFSA's internal database that is connected to the web interface. The validated data is then drawn by a suite of analytical tools to provide insights on financial position, risk trends or compliance/breach data. This can be supplemented at minimal cost to allow uploads in excel or other data file formats, thereby further reducing the regulatory reporting burden faced by regulated entities and the scope for operational errors in the data submission process.

Data-pull approach. Another approach is a data-pull approach, which dictates that a supervisory authority "pull" data directly from the IT systems of supervised entities. The National Bank of Rwanda (BNR) has implemented an ADR SupTech solution based on data-pull approach[22]; the BNR can access the IT systems of a regulated entity and pull out the required data from the IT systems of that entity based on its requirements. The approach was implemented with the intention of reducing time and costs, delays in reporting, and increasing scope, quality, and reliability of data. It should be noted however, that an ADR solution based on data-pull approach requires a higher level of resource commitment by regulated entities, as every regulated entity would be forced to invest in preparing its IT systems and data structures to match the specifications of the data-pull solution developed by the regulator.

The capabilities of an ADR solution can be expanded by appending tools or applications based on specific technologies (such as NLP and text mining), specific types of data (such as qualitative or behavioral data) or specific functionalities (such as data validation, consolidation, visualization and analytical tools) on a plug & play basis.[23] For example, ADR can be appended by adding: (i) a visualization tool to prepare reports for various internal and external stakeholders; and (ii) a risk assessment engine using AI and/or ML technologies to calculate and dynamically monitor risk scores for regulated entities. Such additions can then support the risk assessment and supervisory dashboard for monitoring purposes. For example: the Reserve Bank of India uses AI and/or ML based predictive analytics engines to enhance their risk assessment capabilities[24]; the Monetary Authority of Singapore uses a reporting dashboard identifying risk trends and outliers; the National Bank of Austria[25] uses tools based on ML technology for data validation which can predict the probability and pattern of errors in a submission.

ADR solutions enable a regulator to conform to the fundamental principles of risk-based supervision, relying on valid and accurate data as the basis for analysis. The use of technology-enabled solutions streamlines the handling of data, which preserves integrity from submission through to the output of analysis critical for risk-based supervision. ADR solutions have led to demonstrably lower levels of regulatory burden for regulated entities and increases in the efficiency and capacity of supervisors. The main downside is the cost implications and the need to ensure the existing legacy systems can work seamlessly with the new technology. Importantly, the possibility of gradual implementation increases the feasibility of ADR solutions for IDA countries; the budgetary constraints may lead them to adopt a gradual approach to automating data collection and possibly other data management processes to achieve efficiency and integrity gains.

Credit Risk Assessment

The COVID-19 pandemic is a fast-evolving global crisis, causing many FIs to face major challenges in liquidity management, as was also the case during the GFC. Liquidity crises arise from maturity mismatching and a resulting lack of cash and liquid assets as they are needed. This is exacerbated by business interruptions and a drying up of credit facilities, making liquidity management difficult. Monitoring the change in

liquidity in markets is important to prevent situations such as the run on banks seen after the GFC, which caused the failure of a number of banks. Regulators have a role to negate and manage the liquidity risks resulting from the changing market conditions and thus are requiring FIs to provide liquidity risk metrics more often. Regulators request frequent submission of liquidity or credit risk data as well as information on the capital buffers held by FIs, initially, to monitor the immediate impact of their policy decisions and later, to monitor the recovery process in the post crisis stage. A daily view of liquidity risks has begun to be the new standard, leading the amount of data that regulators must analyze to be overwhelming. This effects regulators and supervisors the world over, as they adapt to the changing environment; IDA countries, where capacities are severely limited, can be particularly overwhelmed by the deluge of data.

Suptech can bring efficiencies to risk reporting. It can automatically identify and monitor risks according to internal methodologies or regulatory definitions, and create alerts and trigger automated actions when pre-determined risk levels are reached. . Risk analytics can be computed on larger volumes of more complex data in a much shorter timeframe as a result of automation, artificial intelligence, cognitive analytics and other Suptech tools are being used to transform raw data for cognitive and analytic processing. Evidence from developed and emerging markets reveal the transformative capabilities that the application of SupTech through innovation in Big Data technology can have on credit risk assessment processes; credit risk assessment relies heavily on data collection and data management tools, covered in the discussion above (Use Case 1: Automated Data Reporting). This section focuses on the ways that SupTech applications can use the data collected to inform risk assessments, and in particular credit risk.

Countries that have implemented used innovative SupTech applications to inform risk assessments include the Bank of Italy (BoI) De Nederlandsche Bank (DNB), the Central Bank of the Russian Federation (CBR), China Banking and Insurance Regulatory Commission (CBIRC), and the Bank of Thailand (BOT). The Bank of Italy has explored how loan default forecasting can benefit from the use of ML algorithms, merging different data sources for this purpose (e.g. the Central Credit Register, the balance sheet data of non-financial firms and other firm-level data); this blend feeds into an ML tool that produces forecasts of loan defaults for comparison with the standard models. Another example is the case of the CBIRC[26], where off-site surveillance (not limited solely to credit risk) is conducted by using simple indicator analysis such as time series, cross sectional or peer group analysis to analyze the data collected; this is then depicted via a traffic light display for ease of consumption.

Some more advanced cases include the DNB, which has studied the use of neural networks to detect liquidity problems at banks in anticipation of potential deposit runs[27], and some countries use social media and public sentiment to supplement their supervision. The CBR has designed software that accelerates the credit risk internal ratings-based (IRB) approach supervision process; it does so by running statistical tests to check the level of accuracy, discrimination and stability of banks' models for calculating capital requirements. In a similar vein, the BOT has put in place a credit risk assessment model that applies logistic regression and random forest algorithms to granular data from commercial credit contracts in order to generate a credit score for individual lenders.[28]

The use of technology and specifically Big Data to support risk assessments and micro-prudential supervision is a vital and necessary use of SupTech tools. It can provide better calibrated measurements of the credit risk profile of regulated entities and enable more accurate determination of provisioning and other supervisory measures related to credit risk. This comes with the ability to scale up the computational power of risk management cost-effectively. Decision-makers can ask more complex questions and get better answers faster when developing new business strategies. But most importantly, supervisors are able to understand nuances in the data because the need to pre-aggregate data is eliminated, and risks are exposed for analysis.

Workflow Management

Managing workflow in an adequate and efficient way is an important part of any organization. Automated workflows significantly reduce response times, cut down the need for paper-based activities, and provide referencing capabilities to past records and data from

the regulator as well as data from external sources. A SupTech solution that supports this is a Regulatory Information and Workflow Management System (RIS) system.

RIS solutions have been implemented in a range of jurisdictions, including Dubai, Bangladesh, Ghana, Sao Tome, Philippines, Thailand, Malaysia, Hong Kong, Australia and Germany; the solutions used varied in each country, in accordance with local supervision approaches.

The workflows on a RIS can be used to automate several key regulatory activities, including: licensing, off-site supervision, on-site supervision, monitoring of FI compliance, tracking of prudential reporting, production of management information, and support of enforcement processes. The modular structure of a typical RIS solution means that numerous avenues are possible for bolting on a range of different tools; there is flexibility to implement a RIS solution of varying scopes, from being restricted to only one functional area to an entity-wide solution. For instance, a regulator may choose to implement solely a licensing workflow solution, such as that adopted by the San Francisco Federal Reserve and the Bank of Portugal. This workflow automates part of the licensing process of new entities, streamlining manual tasks and ensuring that all the necessary threshold requirements are met, and the relevant departments all have access to the information in real-time, reducing the duplication of efforts. The RIS is capable of handling different types of procedural steps including approval authorities, confidentiality controls and classification levels as well as the capabilities to record and maintain an audit trail.

RIS includes a reporting application to produce both pre-defined and ad-hoc reports as well as visualization tools which can present digital dashboards for supervisors. Given their integrated structure, RIS solutions enable various departments or functions of a regulator to coordinate seamlessly in their processes and use a common pool of data with tools to implement necessary controls and security protocols. An appropriately designed RIS can also be useful to a regulator in improving its human resource planning and utilization in conjunction with its scheduling of tasks as well as performance analysis of its staff.

In all the use cases described, the use of data and data management capability is of paramount importance

5.

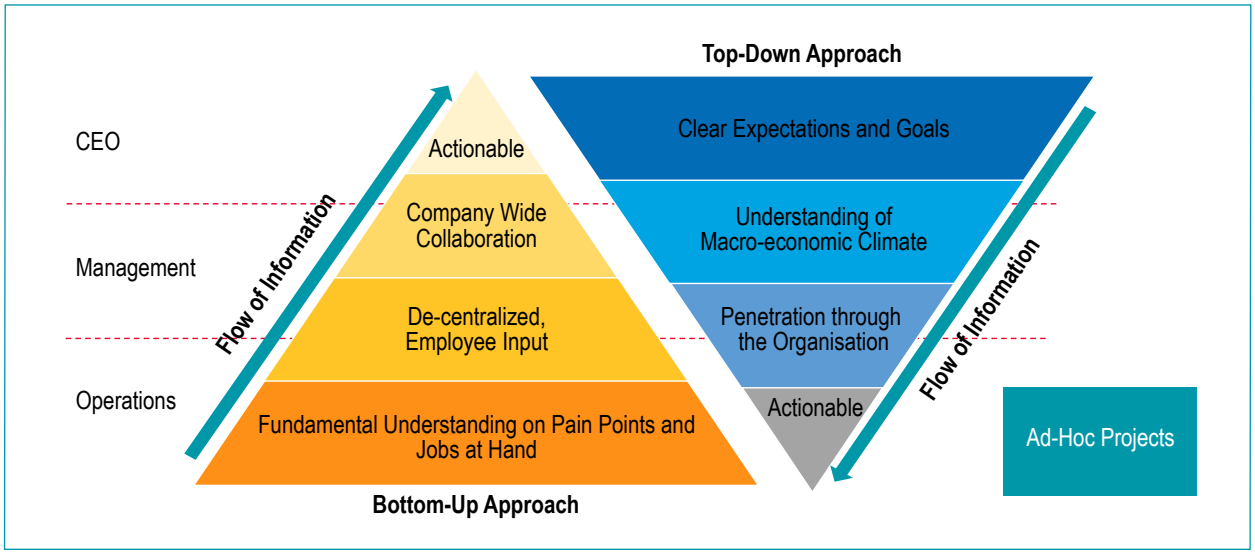
SupTech Strategy and Decision Making

Approaches for Applying SupTech Solutions

Effective functioning of SupTech solutions is not only about the availability of financial and human resources, it is also dependent on how these solutions are implemented. Good business decisions supported by sufficient financial resources can result in less than satisfactory success, if authorities do not pay adequate attention to the nuances of proper implementation. The first step is to design an achievable, well defined and objective-led SupTech strategy. This in turn will support policy priorities and help in assigning the right resources for an effective implementation of SupTech solutions.

Approaches to apply a SupTech solution can vary; some supervisors take a top-down approach, with SupTech strategies and focus areas defined by management, while others assume a bottom-up approach, using a needs and demands driven model that stems from individual departments or even individuals. Implementation of SupTech within an institution can also be in the form of ad-hoc, project-based approaches that do not necessarily permeate into the rest of the organization.

Figure 7. General Approaches to Apply a SupTech Solution



Source: WBG.

Top-down approach. Central strategic leadership is a key component of this approach, which has been observed in the Deutsche Bundesbank, BaFin and BOT, among others. Use cases and scope of work are defined in advance under a comprehensive transformation program with reporting to the Board or Governor. The Board sets up strategic objectives, such as improvement of effectiveness and efficiency of supervision, development of new tools and methods, enhancement of digitization, and efficiency of support functions. Based on this set of strategic objectives, analysis, work plans and objectives across different areas of operations are developed. Thereafter, the dedicated departments or newly established functional units work on the implementation of the strategy. While a top-down approach emphasizes careful planning and oversight, possibly allowing for a wider coverage of the operations and better efficiency, it might also fail to capture fit-for-purpose features of the specific SupTech tools or fail to recognize the 'low-hanging fruit' that are more obvious to those in the operational layers of the organization.

Bottom-up approach. Decentralized leadership is often a component of this approach, favored by the Bank of England and OeNB (Austria). The bottom-up, incremental approach encourages individual operational units to propose and pursue innovations; individual operational units identify problems and opportunities closest to the action and the strategy is built up of 'crowd-sourced' use cases. Some central resources, such as technical expertise, project funding, and coordination with external partners, are made available for specific initiatives. The main benefit of this type of governance is that it allows for more experimentation and agility, as well as a better feeling for what is needed throughout the organization, giving the departments "skin in the game". However, senior management may need to be convinced of the value of the SupTech solutions in order to mobilize resources and inform a broader agenda, making the approach more time-consuming. Also, this approach may lead to implementation of a partial SupTech strategy in the institution that subsequently might generate additional costs and inefficiencies, such as redundant processes, compatibility issues, and repetitive work. Under this type of governance, coordination of efforts and cross-sharing of lessons using a defined overarching SupTech strategy focused on outcomes are essential success factors.

Project-based (ad-hoc) approach. This approach has been seen in jurisdictions such as the CNBV in Mexico, and usually does not involve a broad or linked SupTech strategy. Individual use cases are set up as projects with a clear need-based objective, usually at a department level. The operational departments often engage early with external providers to explore potential solutions. Apart from its flexibility, the benefit of this approach is that it addresses particular needs of individual departments in a timely manner. In addition, it might encourage other parallel projects and obtain broader Board support. Simultaneously however, the project-based approach runs the risk of different initiatives being pursued without having a clear idea of how they link to the other parts of the system. Enhanced coordination between departments and with the Board might be needed to avoid inefficiencies and to ensure ownership and follow-through.

Obstacles to the Implementation of SupTech Solutions

Supervisory authorities can take advantage of any combination of the above three approaches to applying a SupTech strategy. However, irrespective of the type of approach employed; supervisory authorities are likely to face obstacles in pursuing SupTech. For IDA countries, the intensity of these obstacles could be greater due to the lack of resources, capacity and technical know-how, including the absence of referable cases or guidelines. This is especially true given that there is not yet widespread agreement regarding best practices in SupTech globally. The tables below include common obstacles encountered and potential remedies (Table 1), and success and risk factors associated with the implementation of SupTech solutions (Table 2).

The factors and obstacles listed above can be relevant for all jurisdictions; supervisory authorities in IDA countries should pay close attention to them and identify relevant risk mitigating measures before embarking on a SupTech project.

Design of SupTech Strategy

To avoid the obstacles listed above and to optimize use of limited resources in IDA countries, designing an achievable, well-defined, and objective-led SupTech strategy is essential. This is relevant for both top-town

Table 1. Obstacles to the Adoption of SupTech Faced by IDA Countries, and Potential Remedies

Obstacles	Potential Remedies
Lack of Management buy-in; resistence to change	• Begin with a feasibility and cost-effectiveness study • Encourage dialogue with industry • Understand international benchmarks and efficiency gains • Develop a clear view of outcomes and potential cost-savings
Lack of financial resources	• Use a project-based approach: start with small projects that require lower investments and then scale up while keeping focused on the key outcomes • In the longer term, investments in SupTech solutions should bring substantial savings
Insufficient number of staff with the required skills (IT, analytical skills)	• HR policies that are oriented toward hiring and retaining staff with necessary skills (IT, analytical skills) • Capacity building for staff (trainings, workshops, seminars), including with the help of international organizations and other third parties • Use of external vendors to design and implement SupTech solutions, with a subsequent training of staff to use them
Costs and burden for regulated entities	• Constant and detailed dialogue with regulated entities to understand risks, associated costs and other constraints • Holistic strategy at the level of reporting entities and supervisors intended to bring eventual cost savings to both sides
Need to ensure cohesion with existing legacy systems.	• Conduct a feasibility and dependency assessment before implementation • Ensure that all the relevant departments are well cited on the new tool(s) and concerns taken into consideration
Underdeveloped IT infrastructure	• Where possible, IT infrastructure should be upgraded before starting to implement SupTech solutions, which requires significant investment (often at a country level)

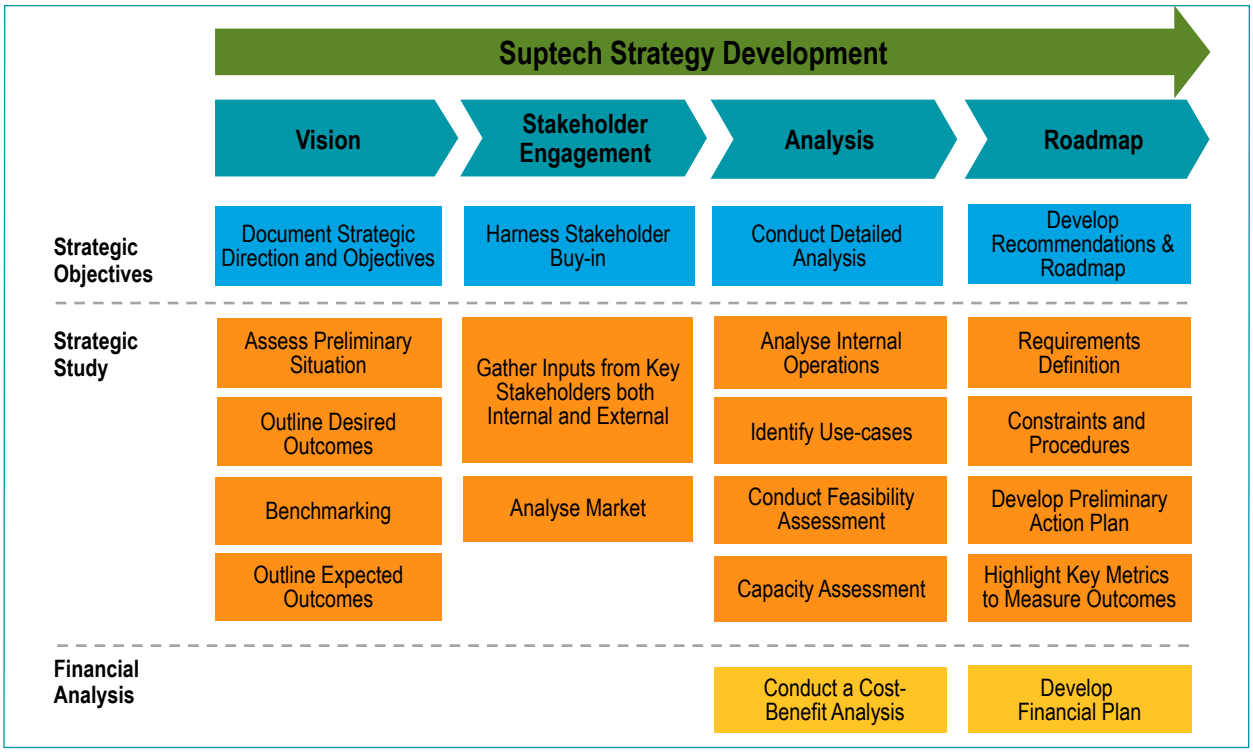
Source: WBG.

Table 2. Common Success and Risk Factors for the Implementation of SupTech Solutions

Success Factors	Risk Factors
• Commitment of Management • Culture and tone from the Top • Motivation of staff • Engagement and communication with stakeholders, including industry • Clear short and long term vision and strategy • Consideration of feasibility and suitability • Periodic measurement of success	• Lack of organizational capability, experience to drive complex transformational projects • Resistance to change • Lack of communication both internally and externally • Failure to identify key stakeholders • Failure to customize and calibrate properly • Failure to manage IT risks • Cost & burden for regulated entities • Issues of compatibility with existing systems • Increased risk of cyber attacks

Source: WBG.

Figure 8. General Approaches to Apply a SupTech Solution



Source: WBG, template for illustration only.

and bottom-up approaches described previously. For a successful SupTech strategy, the following main facets should be considered.

1. Vision: The number and complexity of challenges faced by supervisory authorities in IDA countries require the establishment of a clear, concise and agile vision toward a data-driven and tech-enabled future state. Supervisors should be careful to not be distracted by purely topical issues and allocate resources with the ultimate aim of supporting RBS principles, whether it be through a top-down overhaul of the supervisory process or more targeted use cases based on a bottom-up needs analysis. The failure to establish a comprehensive outcomes-focused strategy could potentially result in redundant data, high costs for implementation, maintenance and staff training, and potentially fragmented solutions that lack coordination.

2. Stakeholder Engagement: Supervisory authorities should ensure the broad engagement of stakeholders from inception, both within the organization, including importantly the IT and Legal departments, as well as key external bodies. The effectiveness of the SupTech implementation could be lower than expected or significantly delayed due to a lack of buy-in throughout the organization, and the inability to integrate with other systems- internal or externally in the market. Regulated entities can be exposed to increased regulatory burden or compliance cost, whether direct or indirect. Authorities should have a clear understanding of the impact that the SupTech implementation will have on their regulated entities.

3. Analysis: In order to arrive at the right strategy and roadmap, one that is compatible with all areas of the organization, an analysis of the needs, internal operations, and capacity should be conducted, along with financial analysis. A supervisor can take advantage of diverse methodologies such as: gap analysis, focusing the gap between the current state and target conditions; cost-benefit analysis to identify supervisory effects; or risk analysis to consider potential risks (e.g. cybersecurity, IT risk, Black box risks) associated with

Table 3. Analysis Criteria to Determine Supervisors' Readiness (Sample)

Obstacles	Potential Remedies
Use Case	• Has a needs analysis been conducted with relevant operational areas? • Have any synergies been identified?Are there any low hanging fruit?
Resources	• What is the time-frame for the project?What is the financial requirement? • Do the benefits outweigh the costs?
Capacity	• Adequacy of IT staff to cope with implementation and managing SupTech? • Adequacy of training and capacity development for Supervisors using SupTech? • Number of resources that can be dedicated to SupTech? • Should the help of an external firm be considered?
Organizational framework	• Is the organizational structure effective for SupTech or flexible to change? • How effective is the internal communication for collaboration between departments when adopting SupTech? • What is management's depth of understanding and commitment to SupTech?
Data Constraints	• Is there enough data available? • How robust is the data quality? • How is the data currently collected? • Do a number of different departments need access to the same data?
Underdeveloped IT infrastructure	• Where possible, IT infrastructure should be upgraded before starting to implement SupTech solutions, which requires significant investment (often at a country level)

Source: WBG.

SupTech implementation. Irrespective of the type of analysis, its scope should cover the overall financial market and not be limited to the supervisory authorities. Table 3 highlights some sample analysis criteria as a starting point for policymakers.

4. Roadmap: When planning roadmaps, supervisory authorities should pay careful attention to the following: Requirements Definition, Constraints, and Procedures. Requirements Definition involves identifying and defining all requirements essential to a SupTech project prior to its implementation. Having clearly defined requirements enables all relevant departments and stakeholders to participate and collaborate with each other effectively. Constraints are typically limited to the budget and time that can be allocated to a particular SupTech project, which will be important for many strategic decisions, including: how to allocate resources within individual projects, whether to self-develop or outsource, how to manage afterwards. Procedures need to be very detailed and defined in step by step fashion. Defined procedures not only prevent cost and time overruns, but also mitigate the disruptive effects of any personnel changes.

Implementation of SupTech Strategy

After the identification of needs and priorities has been finalized and a SupTech strategy and roadmap approved, the next stage is implementation. This Section aims to simplify SupTech strategy implementation by describing the core elements that should be understood and properly addressed, including the basic steps and challenges when pursuing a SupTech implementation project. It should be noted, however, that there are varied factors (e.g. the national specifics, organizational culture, project complexity etc.) that can influence and potentially cause deviations from the models described in this chapter, requiring recommendations and implementation measures to be tailored accordingly.

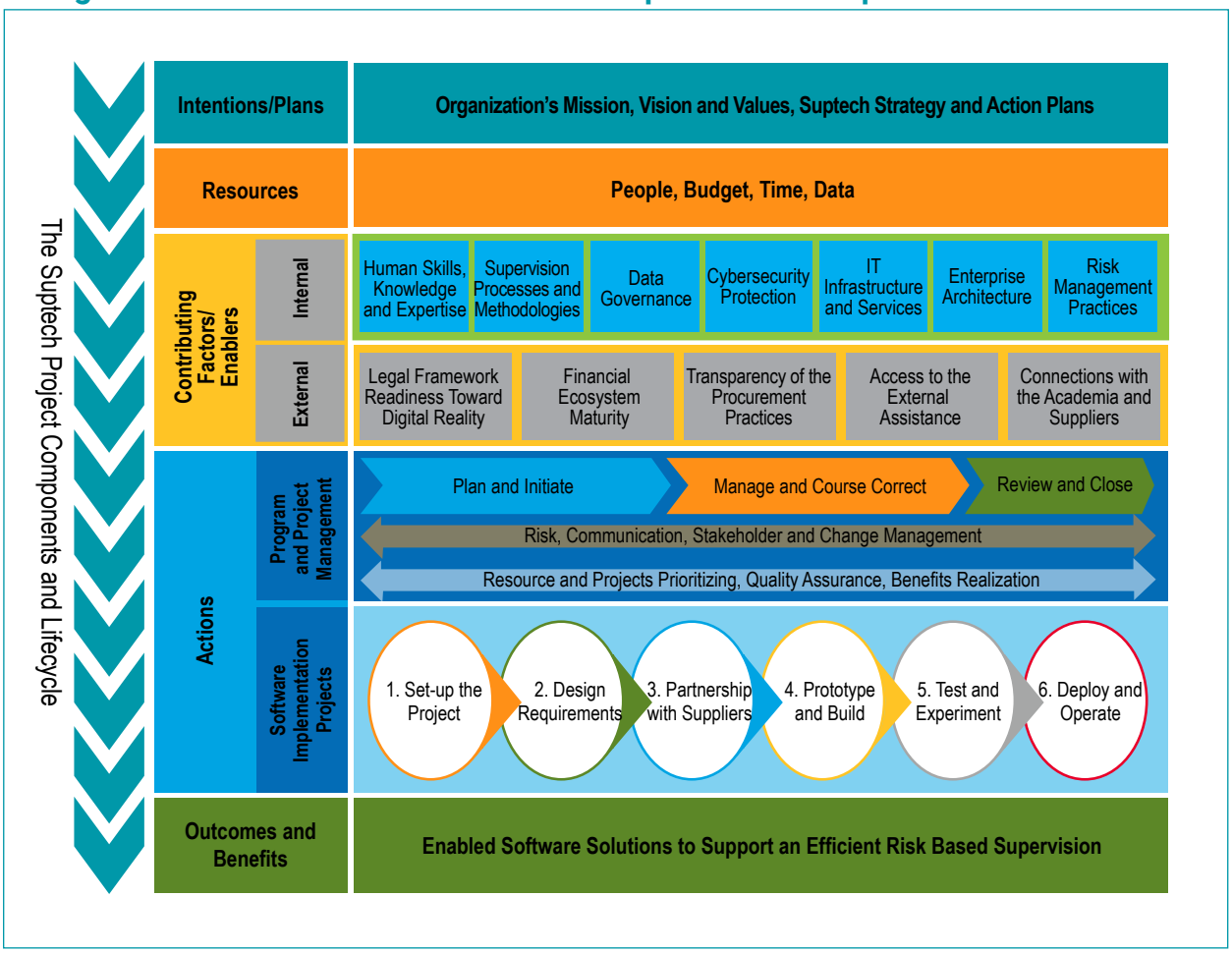
In many cases, a failure of SupTech strategy implementation is a result of an imbalance between the ambition of the strategy and the resources and capacity available to implement it. Many implementation projects have failed because they lacked good leadership, were poorly defined, had inadequately set requirements, lacked stakeholder involvement, had no change control system in place, had been poorly tested, or suffered from some combination of the above. Hence, to succeed in the implementation journey of a SupTech strategy towards the desired outcomes and benefits, it is critical for the supervisor entity to correctly understand how to approach implementation holistically, and make realistic estimates of the complexity of projects and the need for resources for their successful implementation.

Figure 9 is a schematic representation of the most important elements that need to be understood and addressed when pursuing SupTech strategy implementation.

The ingredients' list for a successful implementation starts with the SupTech vision and strategy, which gives the necessary incentives to transform established objectives into realized outcomes. Each of the components of SupTech project implementation, shown above in Figure 8, must be executed well for a project to succeed. The 3 major components are described in detail below.

Resources are the basic element needed to engage in SupTech implementation. If a change effort is going to

Figure 9. Core Elements of a Detailed SupTech Roadmap Imlementation Plan



Source: WBG.

succeed, then the right resources need to be aligned. That means that people, finances, and data assets need to be realigned so that an organization has the right people in the right place, with a realistic budget and the right capacity to make a successful and sustainable change. If any of these items are misaligned, the probability of completing a successful SupTech implementation initiative will significantly decrease. At the end of the day, this could be taken as an axiom: no sustainable implementation can take place without appropriate allocation of resources!

Contributing factors/enablers have the potential to influence whether the implementation of the SupTech strategy will succeed. Lessons learned have demonstrated that certain projects with the right resources didn't succeed because of barriers, or in other words, because of the lack of particular enablers. Having the right enablers in place can drive the achievement of objectives. At the same time, they must be considered in terms of interconnectedness, as each one needs the input of others to be fully effective. For instance, supervision processes need a good data management capability, and in turn good data management needs appropriate skills and expertise, clear policies, tools, processes and so on. The successful implementation of a SupTech project is enabled by the right tone from the top, clear vision, and a disciplined approach. These enablers are in turn determined by dedicated people, good governance practices, and the right corporate culture.

Actions determine the ultimate success or failure of a SupTech strategy because without actions, the strategy's goals remain unattainable.

Program and project management are essential; the support for actions comes from a comprehensive and disciplined program, with strong project management practices in place. To achieve the desired benefits, core actions are essential: using standardized project and program management practices; engaging and managing stakeholders' expectations; creating and managing effective communication plans; thoroughly executing project plans; identifying, measuring and communicating the expected benefits of change; and actively supporting the change.

Like any other supervisory policy, the SupTech strategy should be open to an evaluation of its effectiveness. Monitoring and review should be conducted on an ongoing basis and a structured review procedure should be put in place. This will not only prevent cost and time overruns, but also mitigate the disruptive effects of any personnel changes. At the same time, the supervision entity should be prepared for the fact that software projects are very rarely, if ever, executed strictly according to the initial approved plan. Deviations are often inevitable, sometimes resulting from a change in circumstances or newly identified risks. Thus, adaptability and agility mindsets should be onboarded as key features of the project management practices.

Software implementation projects must be carefully designed and executed. Figure 9 points to six key stages that should be considered for a successful SupTech implementation project, namely:

- ***Stage 1. Set-up of the project*** — this stage encompasses preparation for a new software implementation project. All-critical planning steps and decisions about implementation strategies, the implementation team, timeline and budget happen at this stage. If done well, this stage creates a solid foundation for the next stages.
- ***Stage 2. Design requirements*** — this stage is where the vision and objectives are transformed into key design features and specific solution requirements, addressing all relevant components (e.g. business processes and methodologies, data model, architecture requirements, interoperability, security, performance, flexibility, maintainability etc.).
- ***Stage 3. Partnership with suppliers*** — considering the complexity and diversity of the technologies involved in a SupTech strategy, it is common to work with partners and third parties to procure bespoke or 'off-the-shelf' solutions. This stage is when the procurement process or requests for tender are put forward and contractual agreements are agreed upon.
- ***Stage 4. Prototype and build*** — after setting up the organizational and project arrangements with the supplier, this stage focuses on transforming the design ideas into prototypes that can be assessed by early users before full deployment. Based on feedback obtained and further increments being built, by the end of this stage the agreed functionality should be ready to test.

- ***Stage 5. Test and experiment*** — the aim of this stage is to assure that the end solution will meet all the acceptance criteria established formally by the supervision entity. During this stage a test plan should be established, and the required environments should be prepared to test the individual and integrated solution components, including the supervision processes, performance and capacity, security, internal controls, operational practices, data quality, privacy requirements, and workloads.
- ***Stage 6. Deploy and operate*** — this stage starts with thorough preparations to transfer the final accepted solution, the new business procedures, infrastructure and other supporting services from testing to the production or live environment, in accordance with organizational change management standards. After successful transfer, the efforts should focus on embedding the new approaches by tracking implemented changes, assessing the effectiveness of the operation and use plan, and sustaining ongoing awareness through regular communication and trainings of the new staff.

For each stage, a number of critical activities have to occur and specific risks to be addressed. Annex 2 explores some insights in detail, by proposing a set of typical actions that are to be taken in each stage. These activities could be used by a supervisory entity as a checklist, in order to obtain a reasonable level of assurance that most of the material concerns were addressed by the implementation team when engaging in a SupTech implementation project.

Along with the strategy, it is also extremely important to adopt a set of guiding principles to help supervisors to make the right decisions. When facing new challenges and situations full of uncertainty during implementation, the guiding principles can help to keep the implementation aligned with the organization's mission, valued behaviors and desired culture. Below are recommended key principles that could be tailored for a country specific circumstance:

1. **The right balance** — Target the SupTech strategy objectives to obtain the optimal balance between the stakeholders' expectations, risk factors, supervisor's experience and motivation, and technology. opportunities to maximize synergies and benefits
2. **Design thinking as a strategy for innovation** — Strive first to build the right thing, then build it in the right way. A design thinking mindset will help explore the solution's impact and bring innovation to traditional ways of supervising. Integrating the needs of supervisors and supervised entities, the possibilities of technology, and the business objectives can lead to an efficient supervision and sound financial sector.
3. **Agility in delivery** — Adopt an iterative and adaptable approach, making continuous improvement through incremental gains. This is also the best way to build trust with stakeholders, by delivering frequent demonstrable and sustainable progress and benefit realization.
4. **Easy to use tools** — The more a supervisor has to understand the underlying technology, the less productive that supervisor is. That is why SupTech applications should be required to have a common "look and feel," be intuitive and support user-friendly interface.
5. **Integrated environment** — Develop an integrated information environment, replacing isolated systems to accomplish the tasks outside of the enterprise's integrated information environment.
6. **Efficient data management and improved analytics capabilities** — Consider the readiness and maturity of the existing supervision model to shift to a digital paradigm, starting with the data model and the capability to assure an efficient and secure way of managing the data assets. The amount of information to be processed will continuously increase, and every piece of information is of critical importance to assure the soundness of supervision decisions. This means that significant effort is required to collect, understand, and cleanse the various sources of data, so that the right connections can be made between the various pieces of data.
7. **Built-in security** — In an openly collaboration environment, the sensitive data requires that security be an integral part of all facets of the new SupTech environment; data security and encryption, services security, and security in application design are critical. All layers and components have to consider the rising threat of compromising data confidentiality, which is more prevalent than ever.

6. Conclusion

Financial supervision has been undergoing a paradigm shift, driven by technology that creates opportunities for the development of sophisticated and data-intensive approaches to supervision. The COVID-19 pandemic has laid bare challenges in the system including: the inability to conduct face-to-face supervision; heightened liquidity, credit and operational risks; and pressure on the regulator to adapt quickly. SupTech offers an increasing range of products and services, from standardizing, digitizing and automating basic supervisory procedures and working tools, to solutions that could radically change financial supervision by expanding supervisory scope, transforming procedures and techniques, and increasing timeliness of supervisory assessment.

Evidence from developed and emerging markets reveal the transformative capabilities of SupTech. Key elements of success are: establishing a well-designed strategy with the engagement of internal and external stakeholders; setting a clear vision and objectives; adopting an approach that fits the country's specifications; and starting small with the ability to incrementally develop tools. The longer-term potential cost savings offered make SupTech a worthwhile investment. However, Suptech is undeniably in its early days.

However, it could mean a radical departure from current supervisory approaches and raise a range of opportunities and questions for financial authorities across the globe. The intensive use of digital data and the automation of supervisory procedures could result in important efficiency and effectiveness gains that many authorities seek. But it could bring new problems and uncertainties, for instance, by making the impact of potential cyberattacks or operational failures much more serious than when using manual and paper-based procedures. Moreover, AI/ML models have black box issues and the risk or potential bias in the models requiring a level of algorithmic governance that is still being debated globally.

While many of the guidelines suggested in this paper can be applied to countries at different income levels, IDA countries have resourcing, budgetary and capability constraints which might deter them from implementing SupTech solutions. The maturity of the financial sector, the existing IT infrastructure, the resources and capacity of the supervisory authorities, and many other factors should be carefully analyzed before deciding on the implementation of SupTech tools in IDA countries. However, IDA countries should be acutely aware that if change is to succeed and

they are to catch up with and try to keep pace with the evolving regulatory landscape, the right resources need to be aligned, as in time the pressure on supervisory authorities will only increase. That means that people, finances, data assets need to be realigned so that an organization has the right people in the right place, with a realistic budget and the right capacity to make change in a successful and sustainable way.

Implementation of some of these solutions, such as dynamic and predictive supervision or the use of machine-readable rules to support data reporting, is a step change from the way supervision is conducted currently and raises a number of questions from authorities globally. The use and dependence on data can bring about efficiencies, including faster identification of risks and more streamlined processes and increasing supervisory capacity, but it can also bring new challenges such as increased cybercrime, operational failures or importantly inherent bias in the models.

Supervisors of IDA countries need to recognize that supervision, like the market, needs to evolve and adapt to the new reality. In countries where legacy systems have shallower roots, SupTech could help supervision and regulation leapfrog at a much faster pace than in those countries where systems are more embedded. However, authorities should be strategic in reviewing the current approaches, organizational structures and systems, and consider the long-term development of the financial system, while embracing the transformation of supervision. Supervisors should recognize that a strategic, long-term view of supervision goals is crucial, along with the right leadership and tone from the top to achieve this paradigm shift.

Annex 1.

SupTech Tool Classification

Use Cases	Technologies Commonly Used	Pre-requisite Regulatory Requirements	Other Prerequisites	Risks	Relative Impact on Supervision	Agencies that Have Implemented Similar Solutions
I. Policy Objective: Macro-prudential Supervision						
Early Warning Indicators	• Big data • ML • AI • Or a combination of the above	• Enabling access to data • Intellectual property law (if using external vendors) • Contract law (i.e., principles regarding requirements for a contract to be valid, binding, and enforceable)	• Financial sources • Management commitment • Technical know-how • Suitability & customization • Defined governance & risk management model	• M IT risks • L Cyber-risk • H Computational capacity constraints • M Project management risks • H Failure to customize and calibrate appropriately • H Black box risks • H Data quality and completeness • M Over reliance on tech-models	• One of the critical tools for effective RBS • Enhance predictive capabilities and facilitate proactive macro-prudential measures to address systemic risk trends • Improve risk monitoring capabilities • More effective evidence-based supervision • More precise calibration of regulation and impact assessment • Cuts the time needed for analysis	• De Nederlandsche Bank (DNB) • Bank of Greece (BoG) • European Central Bank (ECB)
Stress Testing	• Big data • ML • AI • Or a combination of the above	• Same as above	• Same as above	• Same as above	• Same as above Exploration of deep-in-the-tail risk scenarios and fat tails	• Bank of England (BoE)
Forecasting (incl. now-casting)	• Big data • ML • NLP	• Same as above	• Same as above	• Same as above	• Same as above	• Bank of Italy (BoI)

Policy evaluation (e.g. heat maps)	• Big data • ML	• Same as above	• Same as above	• Same as above	• Same as above	• Bank of England (BoE) • European Central Bank (ECB) • US Federal Reserve (FED) • Mexico's National Banking and Securities Commission (CNBV)
Tools to Support Financial Inclusion	• GIS	• Same as aboveData privacy law	• Same as above • Government support, public policy goals	• Same as above	• Same as above	• Nepal Rastra Bank (NRB) • State Bank of Pakistan (SPB)
Market surveillance (e.g. suspicious trading detection, market risk assessment)	• Big data • ML • Web-scraping	• Enabling access to data • Standards for cyber security • Data privacy law	• Same as above	• Same as above • M Incentives to 'game' SupTech-based supervision	• Same as above • Efficiency gains, processing of large datasets • Pick up patterns in data that humans cannot • Scope for performing the analysis in real time, just in-time investigation	• Australian Securities & Investment Commission (ASIC) • UK Financial Conduct Authority (FCA, UK) • Securities & Exchange Commission (SEC, USA) • Monetary Authority of Singapore (MAS) Czech National bank (CNB)
II. Applications for AML/CFT Supervision						
Varied applications and use cases for AML/CFT supervision (e.g. risk scoring, detection of networks, compliance with AML requirements, assessment of the likelihood of ML)	• Big data • NLP • Text mining/ Web-Sraping • ML • Network analysis • Graph learning • Supervised learning • Automated random forest decision making	• Enabling access to data • Data privacy law • Payments law (with provisions regarding settlement finality, payments messaging, acceptance/ rejection of payment instructions, etc.) • Securities law (with provisions regarding securities settlement, clearing, delivery, custody, and recordation):	• Financial resources • Management commitment • Technical know-how • Suitability & customizatio • Defined governance & risk management model • Buy-in from supervision staff	• M IT risks • L Cyber-risk • H Computational capacity constraints • M Project management risks • H Failure to customize and calibrate appropriately • H Black box risks • H Data quality and completeness • M Over reliance on tech-models	• Improve risk monitoring capabilities • One of the critical tools for effective RBS in relation to financial crime • Enhance capabilities for accurate risk assessments; to facilitate more effective RBS measures to address risks in AML/CFT & financial crime • More effective evidence-based supervision	• Bank of Italy (BoI) • National Bank of Rwanda (BNR) • Monetary Authority of Singapore (MAS) • Bangko Sentral ng Pilipinas (BSP) • CNBV, Mexico • FCA, UK • SEC, USA • AUSTRAC, Australia • FINTRAC, Canada • Financial Intelligence Centre of South Africa (FIC) • Financial Intelligence Unit of Russia (ROSFIN)

				• M Tools might use effectiveness over time (need to train technology and do updates) • M Incentives to 'game' SupTech-based supervision	• More precise calibration of regulation and impact assessment Reallocation of resources or capacity from more manual work to more judgment-based work • Efficiency gains, processing of large datasets • Pick up patterns in data that humans cannot • Scope for performing the analysis in real time, just in-time investigation	• Financial Intelligence Unit of Finland (RAP) • Financial Intelligence Unit of Italy (UIF) • De Nederlandsche Bank (DNB) Bank of Mexico (Banxico)
III. Policy Objective: Micro-prudential Supervision						
• SupTech tools for institution-wide Risk Based Supervision (RBS)	• Big Data • API • ML • NLP	• Enabling access to data • Regulated entities being in a position to adapt to the demands of the resulting regulatory environment; and afford the related costs	• Financial resources • Management commitment • Human resources – Supervisors with relevant skills to use new analytical tools and methods • Defined governance & risk management model • Buy-in from supervision staff	• H IT risks • M Cyber-risk • M Project management risks • M Failure to customize and calibrate appropriately • M Data quality and completeness	• Critical for implementation of effective RBS framework • Enhance capabilities for accurate risk assessments; facilitate RBS measures with a higher degree of sensitivity to risk profile of the regulated entities. • Improve risk monitoring capabilities • Can materially enhance efficiencies in supervisory processes and overall productivity of the supervisory organization • More effective evidence-based supervision • Cuts the time needed for analysis • Reallocation of resources or capacity from more manual work to more judgment-based work	• Deutsche Bundesbank (DB) • Bangko Sentral ng Pilipinas (BSP) • Australian Prudential Regulatory Authority (APRA) • Bank of Thailand (BOT) • Hong Kong Monetary Authority (HKMA) • Bank Negara Malaysia (BNM)

Risk Assessment Tools						
Governance	• NLP	• Same as above	• Same as above	• M IT risks • M Cyber-risk • M Project management risks • H Failure to customize and calibrate appropriately • H Black box risks • H Data quality and completeness • M Over reliance on tech-models	• Improve risk management cities • Significantly enhance breach detection capabilities as well as flag emerging risk trends • Impact assessment without increasing reporting burden • More effective evidence-based supervision • Cuts the time needed for analysis • Reallocation of resources or capacity from more manual work to more judgment-based work	• Bank of Thailand (BOT)
Credit risk	• ML • Automated random forest decision making Big data	• Same as above	• Same as above	• Same as above	• Same as above; • Better calibrated measurement of credit risk profile of regulated entities • Enable more accurate determination of provisioning and other supervisory measures related to credit risk	• Bank of Italy (BoI) • Central Bank of Russia (CBR) • Bank of Thailand (BOT) • De Nederlandsche Bank (DNB)
Liquidity risk	• Neural networks	• Same as above	• Same as above	• Same as above	• Same as above	• De Nederlandsche Bank (DNB)
Cyber-risk		• Same as above	• Same as above	• Same as above	• Same as above	• European Central Bank (ECB)
IV. Applications Related to Data Collection						
Automated reporting	• Data input approach • Data pull approach • APIs	• Enabling access to data • Data privacy laws • tandards for cyber security • Data protection law	• Financial resources • Management commitment • Human resources – IT skills • Human resources – talent to use outputs from SupTech in RBS	• H IT risks • H Cyber-risk • M Project management risks • M Failure to customize and calibrate appropriately • M Costs & burden for	• Improve off-site monitoring and allows for better and earlier detection of potential risks • Integration with daily operations and staff workflows, support analytical work	• Australian Securities and Investment Commission (ASIC); • Austrian National Bank (OeNB); SEC, USA; Bank of Greece (BoG); Central Bank of Nigeria (CBN) • ASIC, Australia; National Bank of Rwanda (BNR);

					• Faster and more flexible data capture from supervised firms, harmonization of data collectionCuts the time needed for data collection • Reallocation of resources or capacity from more manual work to more judgment-based work • Decrease in operational risk, i.e. human errors • Improvements in financial institutions' data quality	• Bangko Sentral ng • Pilipinas (BSP); FCA, UK; Reserve Bank of India (RBI) • ASIC, Australia, Bangko Sentral ng • Pilipinas (BSP)
Real-time monitoring (e.g. capital markets, consumer complaints)	• Big data • API • Dynamic visualization	• Same as above	• Same as above	• Same as above	• Same as above • Scope for performing the analysis in real time, just in-time investigation	• ASIC, Australia • Bangko Sentral ng Pilipinas (BSP) • CNBV, Mexico • FSS, South Korea
V. Applications Related to Data Management Function						
Consolidation	• Big data • API • Cloud computing • ML	• Enabling access to data • Data privacy laws	• Financial resources • Management ommitment • Human resources – IT skills • Human resources – talent to use outputs from SupTech in RBS • Defined governance & risk management model • Buy-in from supervision staff	• H IT risks • H Cyber-risk • M Project management risks • M Failure to customize and calibrate appropriately • H Black box risks • M Systems integration risks – across all units and functions	• Improve off-site monitoring and allows for better and earlier detection o Capital Markets Development • Integration with daily operations and staff workflows, support analytical work • Cuts the time needed for data work • Reallocation of resources or capacity from more manual work to more judgment-based work • Decrease in operational risk, i.e. human errors • Expanding data utilized beyond institution-reported data	• Deutsche Bundesbank (DB) • Bank of Italy (BoI) National Bank of Rwanda (BNR) • FCA, UK • Central Bank of Nigeria (CBN)

Validation	• ML (unsupervised and supervised learning) • AI • API	• Same as above	• Same as above	• Same as above	• Same as above • Integrity and consistency of reported data – in relation to audited financial statements and risk data • Ensure calculations of metrics reported as a part of prudential reporting to be in line with reporting rules	• Monetary Authority of Singapore (MAS) • Austrian National Bank (OeNB)
Visualization	• Dynamic visualization • Big data	• Same as above	• Same as above	• Same as above	• Same as above • Facilitate easy monitoring, quickly absorb and understand data • Present information to supervisors in a readily omprehensible way • Supports decision making and facilitates prompt & more effective RBS	• Federal Reserve SF • Bank of Portugal (BoP) • UK Prudential Regulatory Authority (PRA)
VI. Applications Related to Licensing and Authorization						
Applications related to licensing and authorization	• Text mining • NLP	• Enabling access to data • Data privacy laws • Legal framework to allow submission of documents and declarations in a digital mode	• Financial urces • Management ommitment • Human resources – IT skills • Human resources – talent to use outputs from SupTech in RBS • Defined governance & risk management model • Buy-in from supervision staff • Acceptance of the legal department to allow decision making and evidences based on digital records and information	• H IT risks • H Cyber-risk • M Project management risks • M Failure to customize and calibrate appropriately • M Systems integration risks – across all units and functions • H Black box risks	• Cuts the time needed for analysis • Reallocation of resources or capacity from more manual work to more judgment-based work • Can materially enhance process efficiencies in licensing processes – an essential process-driven activity • Contribute to overall productivity enhancement of the supervisor • Facilitate identification & recording of potential breaches as well as evidence of compliance with threshold requirements – key to decision making on licensing	• Federal Reserve SF • Bank of Portugal (BoP) • UK Prudential Regulatory Authority (PRA)

Annex 2.

Reference Guide for SupTech Project Implementation

Part A. General Overview	
Reference Guide purpose:	This reference guide is intended to draw a brief overview of a fairly common implementation pattern, which would support IDA countries in understanding the basic steps and challenges when pursuing a SupTech implementation project. This guide is intended to be used after the use case has been properly identified and approved (please refer to Chapter V. SupTech Strategy and Decision Making). The typical actions provided for each stage, can be used by supervisory entity akin to a reference checklist, in order to obtain a reasonable level of assurance that material concerns are addressed during a SupTech implementation project.
Methodological approach:	The content of the reference guide is drawn from published literature, including frameworks, standards, and best practices put forward by SSB and other regulators, as well as hands-on experience.
Applicable limitations:	It is of critical importance to know that the guide is not intended to establish a one-size-fits-all, exhaustive or prescriptive approach. There are a lot of factors (e.g. the national specifics, organizational culture, project complexity etc.), that can necessitate deviation from the models provided here. Supervision entities should draw from the guide what is useful and applicable for their contexts and tailor the selected recommendations according to their specific needs.
Additional remarks:	In a SupTech implementation project, the supervisory entity should consider the need to properly integrate and manage across all implementation stages their own processes and capabilities as related to Stakeholders, Risk, Communication, Change management etc. Stage 3. Partnership with suppliers was introduced in order to address the basic steps to be considered when choosing to engage with vendors through a procurement procedure. It is worth mentioning that choosing to work with vendors should be a project strategy and design choice of the supervisor entity. There are countries that have done SupTech implementations in-house and others that have chosen a mixed approach. However, considering the complexity and diversity of technologies required to sustain and enable the implementation of a SupTech strategy, in-house development capabilities, may often prove not to be sufficient, sustainable or optimal in achieving the established goals. Therefore, seeking to partnership with different vendors may become a mission critical stage of the implementation roadmap.

Part B. Recommended Stages and Actions			
Recommended Stages	**Typical Actions to be Taken**	**Important Contributing Factors/ Enablers to be Considered**	**Typical Risk Factors to be Managed**
Stage 1. Set-up the project – Prepare for, and initiate a new project	• Delineate clearly the project scope; • Establish the project governance and approach; • Define some guiding principles to be applied throughout the entire project; • Establish the budget requirements and constraints; • Establish the baseline metrics to measure the progress and benefits realization; • Define the critical project roles and designate the project team; • Assess the preliminary project risks and establish adequate measures to manage them. Please refer to Annex 1 to understand typical risks involved by SupTech projects, according with the appropriate use case classification; • Define the preliminary project phases and the major milestones. Develop a project schedule that specifies the duration and dependencies of each of the implementation stage; • Establish your quality assurance approach for the project deliverables (e.g. ownership and responsibilities, quality review processes, success criteria, and performance metrics); • Get formal approval from the project steering committee prior to move to the next stage.	• Understand the scope and impact of the envisioned change and stakeholder readiness/willingness to change; • The leading role in the project management should be taken by supervising department, being extensively supported by IT; • Involve experienced project management and team leader resources with skills appropriate to the size, complexity and risk profile of the project; • In addition to IT experts and traditional supervision staff, consider the involvement of data scientists, statisticians, and economists both during the project and for continuous review; • Referring to the SupTech governance models described in Section VI, it is strongly recommended for central strategic leadership (top-down) and decentralized leadership (bottom-up) approaches to establish sound corporate practices for evaluation, prioritization and balancing of different projects that are to be executed as part of the SupTech implementation program within resource and funding constraints; • Aalignment with supervision objectives and priorities, institution's capabilities and capacity to manage changes. For project-based (ad-hoc) approach, where no broad SupTech strategy is presumed to be in place there is still the need to assess dependencies between different running and planned projects to avoid any further inefficiencies and overlays.	• Unclear governance arrangements; • Lack of engaged and passionate people in the project; • Inadequate leadership participation and support from management; • Scarcity of resources (e.g. budget, people, time); • Lack of clarity on the required outcomes; • Lack of readiness for change.

Recommended Stages	Typical Actions to be Taken	Important Contributing Factors/ Enablers to be Considered	Typical Risk Factors to be Managed
Stage 2. Design requirements – High level assessment, preparation of the design and requirements specifications	• Conceptualize the desired state and establish the key design features to be addressed; • Express requirements in terms of how the gap between current and desired business capabilities needs to be addressed; • Use business scenarios descriptions in order to describe in a clear way the expected outcomes; • Define the main characteristics for the target model of the supervision processes and identify existing gaps; • Identify data needs for the target state and clarify if any changes are required in the existing data model and in data management practices; • Draft the functional requirements that should address all the key features needed; • Recognize and define applicable requirements that relate to non-functional characteristics of the software solution, like architecture requirements, flexibility, interoperability, performance, scalability, resilience, usability, maintainability, technological platform, documentation, and last, but not least, security requirements; • Identify existing and future applications that will have dependencies with the desired software solution; • Document all the data flows and the requirements for the interdependencies; Identify the key users' groups and document them for the licensing and training program needs; • Evaluate for design weaknesses (e.g., inconsistencies, lack of clarity, potential flaws) and address them correspondingly; • Confirm acceptance of key aspects of the requirements, including the compliance with legal, regulatory and institution-level policies, internal control system, security procedures, business continuity, auditability etc.; • Review and validate with the relevant stakeholders and get their approval.	• In order to better address the SupTech needs, engage a broad range of stakeholders to identify the different perspectives on the existing issues and brainstorm optimum solutions. Make this exercise as much as possible cross-functional and highly interactive; • Identify innovation opportunities and plan how to benefit from innovation in relation to new supervision needs by launching a Request for Information (RFI) and arranging open discussions with the community (supervised entities, vendors, academia etc.); • Early vendor engagement informs the vendors' community about your intentions, creating the possibility of idea exchange, sharing of various experience in addressing similar challenges; • Data is the core component of any SupTech project. During this stage, it is advisable to seek design approaches that enables minimal data redundancy and improves overall data quality, optimizing at the same time the reporting burden; • Define unambiguous and qualitative requirements, ensure that every requirement meets a basic set of qualities, such as: being concise, correct, consistent, necessary, traceable, testable, achievable etc.; • A business process rethinking and redesign of the workflows that need to be performed in conjunction with the new software solution would be highly desirable during this stage, in order to identify and address as early as possible the legal, methodological and operational barriers that wouldn't allow you to properly shift to the new SupTech enabled environment, and to enhance data collection, validation, analysis, dissemination and decision-making processes. For any further references, seek to understand for example the principles and approaches proposed by the Business Process Re-engineering (BPR) technique and Business Process Model and Notation (BPMN) standard (freely available online).	• Scope and expectations not properly articulated, which leads to poor design and requirements; • Inadequate skills, knowledge and experience to deal with the complexity of setting qualitative requirements; • Tendency to focus solely on controls and performance improvements, not on efficiency improvements and innovation; • Attempting to implement too much at once.

Recommended Stages	Typical Actions to be Taken	Important Contributing Factors/ Enablers to be Considered	Typical Risk Factors to be Managed
Stage 3. Partnership with suppliers – Establish the procurement strategy, define the procurement requirements, engage and partnership with suppliers	• Assess the applicable procurement procedures alternatives and identify the best option that would allow a high level of transparency and in the same time enough flexibility for the negotiations with vendors to obtain a best value for money engagement; • Establish clear conditions for participation and for response qualification, keeping an open and non-discriminatory approach to market players. Conditions of participation should be limited to legal, commercial, technical and financial abilities to fulfil the requirements; • Develop selection criteria to evaluate the available solutions. Criteria can include features, price, platform, innovation and anything else the evaluation team considers to be important; • Develop a contract template and emphasize crucial aspects to be included in the final contract, like payment installments scheme, vendor's responsibilities and obligations, changes in scope, confidentiality arrangements, contract termination, liabilities, disputes, service level agreements, the right to audit the contract execution etc.; • Develop requirements for the implementation services, stating in a clear form the expected vendor's responsibility, the minimum deliverables to be provided and the minimum applicable acceptance criteria; • Develop requirements applicable for project management, after an analysis of the impact of choosing a development methodology (e.g. Waterfall, Agile, hybrid) on the actual institutional processes and practices, available resources, project risks, architecture requirements etc.; • Develop requirements for the post implementation services, including the acceptable levels of service delivery (SLA); • Build-up a solid procurement document, by consolidating all the available building blocks together; • Obtain necessary authorizations from inside and outside of your institution, if applicable; • Submit a request for tender (RFT) and, invite vendors and publish your request on visible and popular places; • Conduct a vendor's conference to explain in detail about the expectations and outcomes and to address any further clarification questions. Demonstrate the process is open and sound to build early trust with the vendors; • Open and assess the bid responses according with the established assessment criteria; • Organize demo sessions with shortlisted vendors, in order to be able to validate the proof-of-concepts that vendors can arrange for you and address any further clarifications;Organize negotiations with the selected vendor in order to obtain the best value for money;Engage in contract signing procedures.	• Incorporate a rigorous procurement risk management approach, which will enable issues to be identified early in the procurement lifecycle and lead to a higher successful rate for a contract signing; • Aside from the assessment of the functional and non-functional features and price to be paid, consider other important assessment criteria that for the vendor evaluation and decision making, such as: • Domain Expertise, project portfolio and references – this is the vendor's general expertise, based on past performance, know-how, experience in similar projects and the references the vendor can provide; • The proposed team – this indicates the specific skills and experience that the team will possess, and should be assessed against the expertise needed to achieve the project goals. Asking for detailed CVs of the team members that will be involved in the project implementation from the vendor's side is necessary to assess the real capabilities of the vendor's team members; • Total Cost of Ownership (TCO) – the project cost is only the visible part of an iceberg. In order to assess what the real costs of possession are over time, it is a good idea to request additional estimations from the vendors, considering such factors like recurrent costs for license maintenance and support, for scaling up the licensing needs, for any further development and upgrades (e.g. costs of man*hour for change requests), associated costs with the required technological platform (e.g. hardware – servers, storage, network equipment; software – operating systems, database management systems, middleware software) etc.	• Procurement failure due to inappropriate requirements (e.g. too restrictive, imposing very high costs for participation etc.); • Procurement failure due to lack in projecting the economic cost of the project (too much underestimated budget); • Inappropriate bidder's responses, due to lack of understanding the full scope, desired outcomes and required services;Internal fraud due to a conflict of interest admitted by an authorized staff involved in procurement decisions and negotiations with vendors.

Recommended Stages	Typical Actions to be Taken	Important Contributing Factors/ Enablers to be Considered	Typical Risk Factors to be Managed
Stage 4. Prototype and build – develop a detailed deployment plan and start to develop the solution's building blocks	• Establish and agree with the implementation partner about all the project organizational key points including the project management plan, project charter, project kick-off date etc.; • Establish with the implementation partner the appropriate development methodology and organizational approach that should deliver the proposed solution in most efficient and effective way; • Review and agree in conjunction with the implementation partner on the detailed deployment plan; • Let the implementation partner conduct a detailed functional analysis and design in order to build the solution building blocks' blueprint, which would consist at least of the following components: solution architecture, data models (physical, logical, data validations, data quality criteria etc.), processes and workflows, interface layouts, security roles etc.; • Assess the existing gaps between the proposed solutions and the requested features. Agree on an acceptable way to deal with each identified gap; • Prepare and deploy the operating environments needed for development and testing of the software solution; • Monitor the execution of the building iterations according with the established plan, and organize early working prototypes demonstration to validate the alignment with expectations and requirements with the key-users; • Ensure that all relevant stakeholders have the ability to review the interim results of the prototype development cycle; • Agree on the data migration strategy if needed and prepare the data sets and the migration scripts accordingly. Check for data consistency and quality. In the same time, identify and prepare the test data sets, considering the concerns of data privacy (e.g. applying puzzling or depersonalization of data);Review and check the completeness and the quality of the stage deliverables according with the established acceptance criteria.	• The build phase along with the analysis and design activities can be run in an agile way by breaking them in relatively small iterations or going through an incremental prototype building. Adapting to agile way of working, would help to obtain a higher predictability on the delivery capabilities and a higher level of user engagement during the earliest stages; • Establish which are the 80/20 tasks (80 percent of the benefit with 20 percent of the effort) and prioritize them in the deployment plan. Relying on quick wins will help to obtain quick visible results.	• Differences in approach and expectations between supervision entity and vendor; • Too optimistic goals, due to underestimation of effort required; • Lack of dedicated resources, or capacity from the implementer's side; • Scope misaligned with requirements or mis-interpreted by implementer; • Continuously changing requirements; • Proposed solutions by the vendor are too complex, or impractical, or there are too many workarounds.

Recommended Stages	Typical Actions to be Taken	Important Contributing Factors/ Enablers to be Considered	Typical Risk Factors to be Managed
Stage 5. Test and experiment – thorough testing planning, key users training and undertaking of the testing activities till the final user acceptance is obtained	• Develop and document a detailed training and testing plan, which aligns to the agreed contractual provisions, project quality plan and institutional applicable policies; • Create and document detailed test cases that align with the plan scope and referred practices. The test cases should address all possible scenarios that might occur; • Create a test environment that supports the full scope of the solution. Ensure that the test environment reflects, as closely as possible, real-world conditions, including the business processes and procedures, range of users, and deployment conditions; • Organize key user training and transfer of knowledge required to acquire the skills needed to operate and administer the day-to-day operations within the new software solution. Key users' groups are considered the final users, operational and security administrators, helpdesk team, infrastructure platform administrators, in-house development team etc.; • Undertake all tests in accordance with the test plan and established practices; • Document the testing results, open tickets for identified errors and classify them according to their severity (e.g., minor, significant and critical). Repeat tests until all critical and significant errors have been resolved; • Perform regression testing to ensure that operated fixes and enhancements don't have any adverse side effects on the previously developed and tested software and if it still meets the original requirements;After meeting all the agreed acceptance criteria, proceed with the final user acceptance sign-off.	• Large involvement of end-users in testing and allocating sufficient time for testing phase are among the most critical success factors to be considered; • The testing plan should cover all applicable testing types, such as unit test, system test, integration test, user acceptance test, performance test, stress test, data conversion test, security test, resilience, backup and recovery tests; • Consider using best practices or refer to relevant standards for an efficient software testing. A good example of standard you can refer to for this purpose is ISO/IEC/IEEE 29119; • For certain type of tests like performance and stress testing, using of automated testing tools are required. In case the supervision entity doesn't have such capabilities, it is recommended to ask them to be provided by the implementation partner; • Use pilots and demos, where appropriate, to experiment with the solution in small scaled deployments, in order to simulate the real-world conditions, or to educate and obtain user's further buy-in and support.	• Insufficient resources for a proper testing; • Unanticipated expans ion(s) in project scope; • Improper training; • Poor quality; • Costly time delays due to new issues identified during the testing stage; • Lack of arranging of a proper testing environment;

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Stage 6. Deploy and operate – Prepare for go-live, operate into production, enable and sustain the change	• Take the necessary steps for go-live preparations, by developing a go-live readiness assessment checklist and production deployment action plan; • Ensure that all interested parties are consulted and are in agreement that the software solution is ready to be launched and that the suggested date and time is convenient for them; • Ensure that there is a roll-back plan, in case something is going wrong; • Develop a communication plan that will facilitate the change enablement. • Ensure that the plan covers a holistic view of the change and provides documentation (e.g., procedures), mentoring, training, coaching, knowledge transfer, enhanced immediate post-go-live support and ongoing support; • Prepare the production environment and execute all the applicable migration procedures, including data transfer; • Go-live and operate the new software solution; • Make process owners accountable for normal day-to-day operations; • Define and apply key steps for project closure, including final acceptance sign-off, the post-implementation reviews that assess whether a project attained desired results and benefits; • Provide ongoing awareness through regular communication of the change and its adoption. Provide mentoring, training, coaching and knowledge transfer to new staff to sustain the change; • Sustain and reinforce the change through regular communication that demonstrates top management commitment.	• After going live and before the final acceptance sign-off, a limited period to extensively monitor the software solution's behavior in daily operation would be highly recommended; • The implementation partner should provide extended on-site support during this period to address any further issue that impacts the normal operation of the software solution; • Additionally, based on received user feedback, it should be assessed whether sufficient knowledge transfer has been provided for a proper day-to-day use of the software solution; • In terms of change management, it is recommended to practice positive reinforcement. Positive reinforcement is the practice of rewarding desirable employee behavior in order to strengthen that behavior. Recognizing and rewarding desirable employee behavior during change is an essential key to motivating employees to be less resistive to changes.	• Poor understanding of how to apply the new processes or tools that have been developed; • Resistance to change and lack of positive reinforcement actions; • Poor communication of successes; • Lack of service desk support to the end-users.


SupTech
BIG DATA

Endnotes

1. Definitions are based on BIS (2018) unless otherwise stated.
2. Toronto Center, 2018.
3. Basel Committee on Banking Supervision (BCBS), 2018.
4. Financial Stability Board (FSB), 2017.
5. The Bali Fintech Agenda, 2018.
6. FSI Insights on policy implementation, No 9 by Dirk Broeders and Jermy Prenio. https://www.bis.org/fsi/publ/insights9.pdf.
7. This definition has been used in a previous WB paper from Spreadsheets to Suptech, 2018.
8. Eligibility for IDA support depends first and foremost on a country's relative poverty, defined as GNI per capita below an established threshold and updated annually ($1,175 in fiscal year 2020). Throughout this entire document, all references to IDA countries also include FCV countries for ease of reference, unless specific exceptions are spelled out. https://ida.worldbank.org/about/borrowing-countries.
9. The use of SupTech for conduct supervision is the topic of a separate paper that is currently being written.
10. The Financial Sector Assessment Program (FSAP) provides a comprehensive and in-depth analysis of a country's financial sector. FSAP assessments are the joint responsibility of the IMF and World Bank in developing economies and emerging markets and of the IMF alone in advanced economies.
11. The Core Principles for Effective Banking Supervision (Core Principles) are the de facto minimum standard for sound prudential regulation and supervision of banks and banking systems. They are used by countries as a benchmark for assessing the quality of their supervisory systems and for identifying future work to achieve a baseline level of sound supervisory practices (BIS, 2011).

12. Mutual evaluations are conducted by the FATF as peer reviews of each member on an ongoing basis to assess levels of implementation of the FATF Recommendations, providing an in-depth description and analysis of each country's system for preventing criminal abuse of the financial system.
13. Mutual Evalutions. https://www.fatf-gafi.org/publications/mutualevaluations/?hf=10&b=0&s=desc(fatf_releasedate).
14. Big data is a field that encompasses ways to analyse, systematically extract information from, or otherwise deal with data sets that are too large or complex to be dealt with by traditional data-processing application software.
15. Basel Committee on Banking Supervision. Core Principles for Effective Banking Supervision, September 2012. https://www.bis.org/publ/bcbs230.pdf.
16. World Bank, assessments of compliance with Core Principles for Effective Banking Supervision (BCP) conducted during the Financial Sector Assessment Program (FSAP) for the period of 2009-2019.
17. There have been a few use cases that look at the potential for a machine readable rule book, hence fine-tuning the reporting rules and guidance. However, this use case has not been described here due to its limited relevance for IDA countries at the present time.
18. The real promise of regulatory technology. https://techcrunch.com/2017/05/09/the-real-promise-of-regulatory-technology/.
19. https://www.busiaessinsider.com/the-regtech-report-global-regulatory-requirements-are-creating-a-huge-opportunity-for-regtech-firms-2016-8.
20. See FCA, BoE, 4th TechSprint https://www.fca.org.uk/events/techsprints/model-driven-machine-executable-regulatory-reporting-techsprint.
21. https://www.worldbank.org/en/topic/fragilityconflictviolence/brief/harmonized-list-of-fragile-situations.
22. CGAP Working Paper, Data Collection by Supervisors of Digital Financial Services. https://www.cgap.org/sites/default/files/researches/documents/Working-Paper-Data-Collection-by-Supervisors-of-DFS-Dec-2017.pdf.
23. Plug & play denotes software or technology applications that are capable of working as and when they are connected to a main system or another software, without need for reconfiguration or adjustment by the user.
24. Use of Regtech by Central Banks and its impact on financial inclusion by Gurung N and Perlman L, DFS observatory, Columbia University.
25. The Suptech Generations, FSI paper by Simone di Castri, Stefan Hohl, Arend Kulenkampff and Jermy Prenio.
26. SupTech application in regulatory statistics and risk monitoring. China Banking and Insurance Regulatory Commission, May 2019. http://pubdocs.worldbank.org/en/684341560127614468/FinSAC-Fintech-11-JinWang.pdf.
27. See Triepels et al (2017).
28. Financial Stability Institute, FSI Insights on policy implementation, No 19, October 2019. https://www.bis.org/fsi/publ/insights19.pdf.

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