Use of Regtech by Central Banks and its Impact on Financial Inclusion

Evidence from India, Mexico, Nigeria, Nepal and the Philippines

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ABSTRACT[3]

There is a growing use of innovative technology for compliance and regulatory purposes by regulators and the entities they supervise, manifesting in the relatively new but rapidly evolving field of 'regtech' – or 'regulatory technology.'

Initial uses of regtech have revolved around use by market participants such as financial institutions, and emerging fintech companies to reduce compliance costs by automating typically manual information gathering and reporting processes. For regulators, regtech is being viewed as potentially improving their efficiencies by not only automating components of their supervisory and regulatory tasks but also significantly enhancing their internal reporting processes. In particular, regtech potentially allows central banks in developing countries to adapt to their expanding oversight scope, a result of rising fintech innovations, especially digital financial services and its positive effect on financial inclusion.

This study looks generally at how regtech is evolving globally and more specifically at how central banks in developing countries are contemplating the use of regtech, the potential use cases, and any impact on financial inclusion. Our research involved desktop research and interviews with central bank officials, providers, donors and consultants involved in global regtech initiatives. We provide examples of regtech use by regulators in India, Mexico, Nigeria, Nepal and Philippines as well as a compendium of the types of technologies that are being used and could be potentially used as regtech. Findings from the research suggest that regtech has the potential to make significant changes to the processes and systems of central banks in developing countries by automating reporting, allowing collection of granular data, providing new flows of information, improving predictive and algorithmic supervision, ensuring proper implementation of constantly evolving rules and integrating internal processes.

The understanding and then adoption of regtech can, however, be challenging in many developing countries that have technology and capacity constraints. In some parts, even though the goal may be to introduce and use regtech solutions, legacy internal processes, lack of policy insights and lack of capacity may in of themselves handicap this goal. In all, this study provides insights into why and how regtech is being investigated by regulators and what solutions are being developed and implemented. It focuses primarily on initiatives related to central banks: outlines the role of the central banks as a user of regtech and presents examples from developed and developing countries. We highlight the potential of regtech to further financial inclusion, and provide some policy solutions and solution iterations that could be employed by regulators in anticipation of implementing regtech solutions, as well as opportunities and challenges.

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ABBREVIATIONS

ACH	Automated Clearing House
AI	Artificial Intelligence
AML	Anti-Money Laundering
AMLU	Anti-Money Laundering Unit
APAC	Asia Pacific Regional Intelligence and Analysis Center
API	Application Programming Interface
ASIC	Australia Securities and Investments Commission
AuRep	Austrian Reporting Services
BFA	Bankable Frontier Associates
BIS	Bank for International Settlements
BNR	National Bank of Rwanda
BoT	Bank of Tanzania
BSP	Bangko Sentral ng Pilipinas
BVN	Bank Verification Number
CBN	Central Bank of Nigeria
CDD	Customer Due Diligence
CFT	Combating the Financing of Terrorism
CFTC	United States Commodity Futures Trading Commission
CIV	Customer Identification and Verification
CNBV	Comision Nacional Bancarias y de Valores
DFS	Digital Financial Services
DFSP	Digital Financial Service Provider
DLT	Distributed Ledger Technologies
DMB	Deposit Money Banks
EdW	Electronic Data Warehouse
EU	European Union
FCA	Financial Conduct Authority
FED	Federal Reserve System
FI	Financial Institution
Fintech	Financial Technology
FIU	Financial Intelligence Unit
FS-ISAC	Financial Services Information Sharing and Analysis Center
FSB	Financial Stability Board
FSP	Financial Service Provider
GFC	Global Financial Crisis
ID	Identification Document
IFC	International Finance Corporation
IT	Information Technology
JamFIRMS	Jamaica Financial Institutions Reporting Management System
JoMoPay	Jordan Mobile Payment
KYC	Know Your Customer
MAS	Monetary Authority of Singapore
MIS	Management Information Systems
ML	Money Laundering
MM4P	Mobile Money for the Poor
MMO	Mobile Money Operator
MNO	Mobile Network Operator
MoU	Memorandum of Understanding
NIBSS	Nigeria Inter-Bank Settlement System

NRB	Nepal Rastra Bank
OeNB	Oesterreichische National Bank
ORIMS	Online Reporting and Information Management System
PSP	Payments Service Provider
R2A	Regtech for Regulators
RBI	Reserve Bank of India
Regtech	Regulatory Technology
RFI	Request for Information
RFP	Request for Proposal
RPA	Rockefeller Philanthropy Advisors
RTGS	Real Time Gross Settlement
RURA	Rwanda Utilities Regulatory Authority
SARB	South African Reserve Bank
SC	Securities Commission Malaysia
SIM	Subscriber Identity Module
SLA	Service Level Agreement
SupTech	Supervision Technology
TCRA	Tanzania Communications Regulatory Authority
TPWG	Transatlantic Policy Working Group
TSP	Technology Service Provider
UIDAI	Unique Identification Authority of India
UK	United Kingdom
UNCDF	United Nations Capital Development Fund
USAID	United States Agency for International Development
WEF	World Economic Forum

1. Introduction

1.1. Study Overview

Regtech – or regulatory technology – is emerging as a means to deploy current and emerging technology solutions to reduce the increasing costs of compliance for companies and to improve internal reporting and supervisory capacity for regulators. Many of the regtech solutions are derived and adapted from existing financial technology (fintech)[4] solutions, but emerging solutions are being developed *de novo* with new technologies to cater for specific regulatory or compliance-related needs.

Regtech needs and solutions can be divided into two discrete, but clearly interlinked segments:[5] supervisory functions for regulators and compliance for supervised entities.

For regulators and supervisors, regtech adoption involves automation of largely manual processes and/or use of new technologies to improve their ability to supervise their respective industries and to efficiently implement regulations.[6] When regtech is used by supervisors for oversight and monitoring, it is often also referred to as 'suptech' or supervision technology.[7] Suptech solutions allow regulators to automate and simplify routine administrative procedures as well as improve complex decision-making processes.[8] We use regtech to describe all regtech solutions, including suptech and differentiate where necessary.

While regtech is a relatively new term, technologies seen in the early iterations of what is now known as regtech were simply innovative adaptations of existing technologies for regulatory-related purposes. Nowadays, regtech is driven by the emergence of new technologies[9] such as machine learning, artificial intelligence, pervasive cloud computing, KYC utilities, distributed ledger technologies and from the rapid development in data and analysis-orientated 'big data' solutions. Together, these make up the 'secret sauce' in regtech solutions and emanate to a large degree from fintech innovations focused on compliance and supervision activities. In assessing then these current and emerging compliance and supervisory foci of regtech, we define regtech as:

> *The adaptation of current technologies and the development of new tailored technology solutions to address regulatory and compliance challenges more accurately, uniformly, effectively and efficiently.*[10]

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[4] Financial Technology. Fintech companies use emerging technology and innovative business models to disrupt the financial industry. We focus on small, technology-enabled, new entrants to financial services rather than large technology firms that are entering the financial services or financial institutions that are increasingly using technology. AFI (2016) *Digital Financial Services Basic Terminology,* available at https://bit.ly/2fipB9g; PwC (2016) *Blurred Lines: How Fintech Is Shaping Financial Services,* available at https://pwc.to/2HM7WDN; WEF (2017) *Beyond Fintech: A Pragmatic Assessment of Disruptive Potential in Financial Services,* available at https://bit.ly/2inenB5

[5] Toronto Center (2017) *FinTech, Regtech and SupTech: What They Mean for Financial Supervision*, available at https://goo.gl/R3vWxH

[6] See Section 5: Emerging Use Cases of Regtech, Exhibit 14: Summary of Regtech Use Cases

[7] Dias, D & Staschen, S (2017) *Regtech and Digital Finance Supervision: A Leap into the Future*, available at https://bit.ly/2GThDQe

[8] See for example the Bank of Russia's suptech solution to undertake daily, automated collection of bank transaction data. FX Finance Feed (2018) *Russia's c-bank invites comments on RegTech and SupTech consultation paper*, available at https://bit.ly/2EBsYUz

[9] See Exhibit 2 below on technologies used in regtech.

[10] The World Bank says that regtech is 'technology used in the context of regulatory monitoring, reporting and compliance to benefit the finance industry.' The World Bank (2017) *Project Information Document/Identification/Concept Stage (PID),* available at https://bit.ly/2GREKL2 . BIS defines Regtech to be innovative technologies that can help financial institutions comply with regulatory requirements and pursue regulatory objectives. BIS (2017) *Some Practices: Implications Of Fintech Developments For Banks And Bank Supervisors,* available at https://www.bis.org/bcbs/publ/d415.pdf . IIF defines it as the use

Both developed and developing countries are developing and implementing regtech solutions[11] to strengthen and secure their financial infrastructure[12] and processes. Not surprisingly, adoption of regtech to date appears to be largely by supervised entities.[13] In particular, financial institutions (FI)[14] with large compliance budgets are embracing regtech innovation to meet their growing compliance demands and to manage risk.[15]

Adoption – especially in developing countries – may, however, introduce new risks and impose new operational and financial challenges that need to be identified and addressed.[16]

Central banks are, however, also increasingly using regtech in new and innovative ways for reporting,[17] risk management,[18] monitoring,[19] and identity management.[20] Exhibit 14 summarizes some regtech use cases from around the world along with the specific issues they address within financial regulators.

Annex I encapsulates the overall premise of the paper, where it summarizes the regtech adoption process for central banks- need identification, procurement process, solution development and implementation of regtech solutions.

A proposed iterative process for undertaking a 'soup-to-nuts' needs assessment and for the development of specific regtech solutions for regulators – and central banks in particular - is outlined in the conceptual development framework in Annex H.

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of technology to solve regulatory and compliance requirements more effectively and efficiently. IIF (2016) *Regtech in Financial Services: Technology Solutions for Compliance and Reporting.* available at https://goo.gl/A62STL

[11] See Exhibit 14: Summary of Regtech Use Cases. In this paper, we follow the UNDP classification of developed and developing countries for the most part. It uses the Human Development Index (HDI) to classify countries. HDI is a composite index of three indices that measure longevity, education and income in a country. to classify countries. Developed countries are countries in the top quartile of the HDI distribution and developing countries are countries in the bottom three quartiles. The term developing countries is, however, being used loosely in this paper. In our research of developing countries, we also included countries that may not necessarily be in the lower three quartiles of the HDI distribution but have high financial exclusion and can benefit from the use of DFS such as Brazil and Russia. Nielsen, L (2011) *Classification of Countries Based on their Level of Development*, available at https://bit.ly/2JEg4n7; and UNDP (2018) Human Development Index, available at http://hdr.undp.org/en/content/human-development-index-hdi

[12] The underlying foundation for the financial system including the institutions, information, technologies and rules and standards which enable financial activities including the effective operation of financial intermediation, exchange of data and information and settlement of payments. IFC (2009) *Financial Infrastructure,* available at https://bit.ly/2qve73Q

[13] See Section 2: The Case for Regtech/Evolution of Regtech

[14] Establishment that conducts financial transactions. In the USA, financial institutions are any person doing business in one or more of the following capacities: bank, broker or dealer in securities, money services business, telegraph company, casino, card club, and a person subject to supervision by any state or Federal bank supervisory authority. FinCen (2018) *Financial Institution Definition,* available at https://www.fincen.gov/financial-institution-definition

[15] See Exhibit 2: Key Technologies in Regtech Innovation, Koehler, C (2017) *How Can Regtech Ease The Risk Management Burden,* available at https://tmsnrt.rs/2iP1D32

[16] See Section 6: Challenges for Regtech Development in Developing Countries

[17] See Bahamas, Canada and Mexico in Exhibit 14: Summary of Regtech Use Cases

[18] See Mexico and UK in Exhibit 14: Summary of Regtech Use Cases

[19] See Austria, India, Nepal, Philippines, Rwanda in Exhibit 14: Summary of Regtech Use Cases

[20] For examples of identity management, see Nigeria in Exhibit 14: Summary of Regtech Use Cases. For more information, see Deloitte (2017) *The Regtech Universe On The Rise*, available at https://goo.gl/LUpKtH. See also Perlman, L & Gurung, N (2018) *The Use of eIDs and eKYC for Customer Identity and Verification in Developing Countries: Progress and Challenges*, available at www.dfsobservatory.com

While the focus of this paper is on the financial industry, central banks in particular, it needs to be noted that regtech has also evolved in other industries.[21]

1.2. Regtech in the Developing World

In the developing world, central banks are faced with new and evolving technology innovations. The introduction of the mobile phone-centric Digital Financial Services[22] (DFS) and its variants in over 90 countries,[23] for example, has been a successful driver to meeting financial inclusion goals in developing countries. But, at the same time, has increased the number of supervised entities and required large-scale changes to laws and regulations to recognize and respond to risks introduced by non-banks participating to national financial schemes, sometimes emerging to be as systemically important as established banks.[24]

DFS has transformed the financial landscape in revolutionary ways, introducing new non-bank financial ecosystem participants as part of what has been termed 'mobile money operators' (MMOs),[25] digital financial service providers (DFSPs),[26] and agents.[27] These entities provide primarily transactional financial services using the mobile phone - a nearly ubiquitous device in the developing world[28] - as the core access mechanism for customers. In many cases, the MMO is a mobile network operator (MNO).[29] The conflation of mobile technology

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[21] As shown in Exhibit 2, Regtech has been developed to help companies with regulations concerning the protection of consumer health and safety, the environment, product quality, cannabis industry and health care industry (patient information protection, patient care practices, etc.). CB Insights (2017) *Regtech Market Map: The Startups Helping Businesses Mitigate Risk and Monitor Compliance Across Industries*, available at https://goo.gl/AV9dn4

[22] DFS focuses on the delivery of basic financial services to the poor at greater convenience, scale and lower cost using technologies like mobile phones, electronic money models and digital payment platforms. Mobile money services – transfer of electronic money using mobile networks, mobile phones and agents – is a type of DFS. Summarized from AFI (2018) *Digital Financial Services,* available at https://www.afi-global.org/policy-areas/digital-financial-services; CGAP (2018) *Digital Financial Services*, available at http://www.cgap.org/topics/digital-financial-services; ITU (2017) *Digital Financial Services Ecosystem,* available at https://bit.ly/2S9tgEI; USAID (2013) *Mobile Money: Defined,* available at http://pdf.usaid.gov/pdf_docs/PA00JQD5.pdf. For an overview of DFS, see also Perlman, L (2018) *Digital Financial Services Primer 2018*, available at dfsobservatory.com

[23] GSMA (2018) *2017 State of the Industry Report on Mobile Money,* available https://bit.ly/2CKPLqF

[24] The eponymous m-pesa DFSP dominates the Kenyan financial services industry, leading to concerns by the government that it's failure would have systemic impact on the economy, for example that an m-Pesa outage would cause loss of revenue in direct excise tax and corporate tax by firms running the systems and reduce confidence in the financial services. BD_Africa (2016) Treasury report reveals fears over M-Pesa's critical role in economy, available at https://bit.ly/2yubO5J

[25] Mobile money operator or mobile money provider is an entity that is licensed to build and provide mobile money services. The requirements to gain license to be a MMO may differ from jurisdiction to jurisdiction. MMO is a type of DFSP. Summarized from David-West, O, Muritala, O & Umukoro, I (2017) *Adoption and Use of Mobile Money Services in Nigeria,* available at https://bit.ly/2GTADhM; Lal, R & Sachdev, I (2015) *Mobile Money Services – Design and Development for Financial Inclusion,* available at https://hbs.me/2EFFGfC

[26] Banks, other licensed financial institutions, and non-banks who supply financial products and services through digital means. A mobile money operator can be a type of DFSP. ITU (2016) *The Digital Financial Services Ecosystem,* available at https://bit.ly/2BiFoNK

[27] A third party acting on behalf of a bank or financial service provider to facilitate transactions with customers. They perform cash-in, cash-out services and may also register new customers. The use of retail outlets as agents can help provide financial services to underserved populations at a lower cost. Summarized from AFI (2013) *Mobile Financial Services Basic Terminology,* available at https://bit.ly/2IOnJ14; GSMA (2010) *Mobile Money Definitions,* available at https://bit.ly/2IeH7HG

[28] Perlman, L (2017) *Technology Inequality: Opportunities and Challenges for Mobile Financial Services*, available at https://bit.ly/2CX3Jdz

[29] Mobile Network Operators (MNOs) have licenses to provide telecommunication services through mobile devices. They can be under the regulation of central banks if they provide mobile financial services. Summarized from afi (2013) *Mobile Financial*

with financial services has allowed and spurred those who are underserved or who have never had access to financial services to adopt these mostly affordable and readily accessible technologies for their everyday use.[30]

Central banks remain under pressure to encourage inclusive innovation while preserving financial stability and integrity.[31] The lack of proper data, tools and resources for regulatory and compliance processes in developing countries can burden central banks and DFSPs[32] due to increases in regulatory complexities and reporting requirements from multiple regulators involved in regulating the DFS ecosystem.[33] This may potentially force central banks to limit innovation in the DFS ecosystem, ultimately impacting on financial inclusion.

Exhibit 1: Impact of Digital Financial Services on Central Banks

As DFS gains traction in developing markets, new ecosystem participants with varying risk profiles and capacities pose issues to often under-capacitated regulators.[34]

Regtech is touted to support central banks' growing responsibilities by building oversight capacity and efficiency,[35] developing tools to supervise and monitor the dynamic and data driven financial sector, driving and solidifying policy-making and associated supervisory needs, as well as allowing them to keep up with innovation and understand customers' needs.[36]

1.3. Study Approach and Scope

We reviewed relevant reports on regtech initiatives and conducted detailed reviews of specific regulators with regtech initiatives using open access data. These scoping findings were used to identify global patterns and evaluate the status of regtech in various countries.

Central bank officials, providers, donors and consultants involved in regtech initiatives were also interviewed to obtain insights and gain a better understanding of the industry, their learnings and challenges.[37]

We do not endorse, but rather highlight specific uses of regtech, presenting these initiatives as potential use cases for other central banks especially in developing countries where such technology can greatly impact financial inclusion and supervision of the DFS ecosystem.

For ease of reading, our findings are discussed in the body of the paper, while references to data sources, definitions and additional information are placed in the footnotes.[38]

Services Basic Terminology, available at https://bit.ly/2IOnJ14; Tagoe, N (2016) *Who Regulates the Mobile Money Operations by Telco's? The Need for an Effective and Robust Legislative and Regulatory Framework in Ghana,* available at https://bit.ly/2qqwG9R

[30] As DFS provides financial access to those who previously did not have access, there may be first time users of financial services in the market. CGAP (2018) *Policy Making and Digital Financial Services,* available at https://bit.ly/2qp6LhW

[31] BBVA (2017) *The Balance Between Innovation and Financial Stability,* available at https://bbva.info/2FF5fy4

[32] See Section 2.3: Regtech for Regulators, Section 6.3: Context

[33] See Section 7: Regtech for Financial Inclusion

[34] See Exhibit 1: Impact of Digital Financial Services on Central Banks

[35] See Exhibit 14: Summary of Regtech Use Cases, Section 2.3: Regtech for Regulators

[36] See Section 2.3: Regtech for Regulators

[37] Interviewees are listed in Annex A. Findings from interviews and desktop research for India, Mexico, Nigeria, Nepal and Philippines are included in Annex C, Annex D, Annex E, Annex F, Annex G

[38] Citations include author or publisher information, date of publication and a link to the document. In cases were the date of publication was not found, citations include the date the document was accessed.

Information in this study reflects research done from November 2017 to September 2018.

2. The Case for Regtech

2.1. Background

From the 1960s to the cusp of the Global Financial Crisis (GFC) of 2007,[39] there has been a large growth in FIs in both size and scope. The complexity of operations for FIs and product mixes increased,[40] becoming more quantitative and technology-driven,[41] driving the emergence of complex regulations[42] and similarly increasing associated compliance costs.[43]

Improvements in computer processing power and improved software solutions have allowed FIs to adapt to the increasing burden of regulatory requirements, however, concomitant technology to supervise and facilitate compliance has arguably not evolved in any significant way since the 1990's.[44] That is, baseline compliance and supervisory reporting tools[45] are still largely Excel,[46] XML[47] and email-based for submission of data to supervisors. Analysis of collected data by supervisors is also largely manual[48] with little feedback available to check whether the requisite data has been provided, whether the data is in the correct format, whether it is accurate, and whether any specific follow up or supervisory actions are needed.

Also, the reporting paradigm is the same: the supervised entity fills in a spreadsheet, sends it to the supervisory authority, who then checks the data and sends any queries to the FI. The process then repeats. Data analysis is usually a separate process with its own variances.

With larger numbers of entities and products to monitor and supervise, the data and supervisory burden on supervisors has exploded. Use of more automated and innovative technology solutions for compliance and supervision has emerged in the concept of specific technology solutions, or regtech, first defined by the United Kingdom's Financial Conduct Authority (FCA) as:

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[39] McKinsey (2018) *How secure is the global financial system a decade after the crisis?,* available at https://mck.co/2OBQO35

[40] Arner, D, Barberis, J & Buckley, R (2017) *FinTech and Regtech In A Nutshell, And The Future In A Sandbox*, available at https://cfa.is/2POCyVl

[41] Cesa, M (2017) *A Brief History of Quantitative Finance,* available at https://bit.ly/2JFkN8b; Dincer, H & Hacioglu, U (2014) *Globalization of Financial Institutions: A Competitive Approach to Finance,* available at https://bit.ly/2rjxQnv; Celik, H (2013) *The Impacts of Information Technologies on Financial Institutions,* available at https://bit.ly/2GSm8Xq; Arner, D, Barberis, J & Buckley, R (2017) *ibid.*

[42] Between 2008 and 2015, there has been a 492% increase in annual volume of regulatory changes. Kocianski, S (2016). *The Regtech Report: Global Regulatory Requirements Are Creating a Huge Opportunity for Regtech Firms*, available at https://goo.gl/YF1paV

[43] Development ASIA (2017) *How Regtech is Helping Banks Manage Risks*, available at https://bit.ly/2CzOC9c

[44] Schutzer, D (2017) *Regtech: Innovation and The Future of Financial Services*, available at https://bit.ly/2udvar1

[45] Based on conversation with RBI, NRB, CNVB, Mann, P (2017) *Regtech: The Emergence of the Next Big Disruptor*, available at https://bit.ly/2gFm2XL

[46] Microsoft excel was introduced for Macintosh in 1985 and for Windows in 1987

[47] XML, Extensive Markup Language, is a computer language that allow users to create self-describing data using tags, elements and attributes. It helps simplify data interchange, enable smart code as well as smart searches. Tidwell, D (2002) *Introduction to XML,* available at https://ibm.co/2EFSPFq

[48] An example of excel-based reporting template can be found in Annex J.

> "[A] sub-set of FinTech that focuses on technologies that may facilitate the delivery of regulatory requirements more efficiently and effectively than existing capabilities".[49]

As fintech and techfin[50] disrupt the financial industry,[51] regtech is being fueled by the rapid technological developments and disruptive innovation in fintech.[52] The underlying technologies of fintech[53] were used and are being used in a regulatory context to drive regtech innovation evolving from the need to reduce compliance[54] costs for FIs, to being adopted by financial service providers (FSPs),[55] fintech companies, central banks and also businesses in other industries for other purposes.[56]

Central banks in particular are exploring new ways to use these new technologies for onsite and real-time analysis. Adoption, however, requires a team with technical, policy making and supervision expertise to spearhead the initiative.[57]

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[49] FCA (2016) *Feedback Statement Call for Input on Supporting the Development and Adopters of Regtech*, available at https://bit.ly/2bXLSrg

[50] Companies leveraging their knowledge of technology and data from their primary business to improve existing financial system processes and capabilities. This may be tech or e-commerce companies that are already connected to large number of clients and hence contains large volumes of data. Summarized from Arner, D, Barberis, J, Buckley, R, et al. (2017) *From FinTech to TechFin: The Regulatory Challenges of Data-Driven Finance,* available at https://bit.ly/2HgS0bq; Shea, R (2016) *Fintech Versus Techfin: Does Technology Offer Real Innovation Or Simply Improve What Is Out There?,* available at https://tmsnrt.rs/2GROwwJ

[51] Infosys (2017) *Fintech Revolution in Banking: Leading The Way to Digital, a*vailable at https://infy.com/2GXyjly; Robles, P (2016) *Five Ways Fintech Upstarts Are Disrupting Established Financial Institutions*, available at https://bit.ly/2aw5ukg; Crook, R (2017) *The Race Is On to Disrupt Traditional Banking,* available at https://bit.ly/2GRbUdX

[52]Accenture (2018) *The Growing Need for Regtech,* available at https://accntu.re/2FG4jcC, Schutzer, D (2017) *Regtech: Innovation and the Future of Financial Servi*ces, available at https://bit.ly/2udvar1

[53] Examples include AI, API, Big Data Analytics, Biometrics, Cloud computing, and DLT. See Exhibit 2: Key Technologies in Regtech Innovation

[54] Conforming to a rule- law, regulation, and standard. Regulatory compliance is a set of guidelines that a business must follow as per the requirements set by regulators. Summarized from International Compliance Association (2018) *What is Compliance?,* available at https://bit.ly/2iNpZbj; The University of Scranton (2018) *A Definition on Regulatory Compliance,* available at https://bit.ly/2wa6w0v

[55] Any person, other than a representative, who regularly furnishes advices, renders intermediary services or both. For example, Financial Institutions and FinTechs. FSB (2018) *FAIS – Understanding the Practicalities*, available at https://bit.ly/2yvf3Kb

[56] See Exhibit 3: Regtech Market Map, Section 2: The Case for Regtech/Evolution of Regtech, Arner, D, Barberis, J & Buckley, R (2017) *FinTech and Regtech in a Nutshell, and the Future in a Sandbox*, available at https://cfa.is/2POCyVl

[57] See Section 3.3: Methodologies for Regtech Development and Implementation

Technologies	Definition	Regtech Impact	Examples
Artificial Intelligence (AI), Machine Learning[58]	Technology that performs tasks that traditionally require human intelligence. Machine Learning is a subcategory of AI that learns from data and recognizes patterns to change existing algorithms to better fit the nature of the data.	Fraud prevention and detection	MAS is developing machine learning algorithms.[59]
Application Program Interfaces (API)[60]	Protocols and tools that allow different systems to interact with each other.	Integration and interoperability between central bank supervisory systems and supervised entities.	BSP is using API for regulatory reporting.[61]
Big Data Analytics[62]	Extract meaning from large datasets of diverse data that may include structured and unstructured data. It is usually based on machine learning or other technologies.	Support for transaction and risk monitoring	
Biometrics[63]	Use of people's unique physical and behavioral characteristics to authenticate their identity.	Robust ways to verify identity	BVN in Nigeria is based on biometrics.[64]
Cloud computing[65]	Delivery of computing services like storage, and analytics over the internet. It reduces capital costs, increases speed in processing by provisioning large amounts of computing resources, and provides elastic resources for scalability among many advantages.	Access to innovative software, standardization of data and establishment of common processes at lower cost	
Distributed Ledger Technology (DLT)[66]	Distributed databases that records and encrypts verified data that can be safely shared and managed on network	Real-time client information sharing	Estonia is using blockchain technology for ID purposes.
Semantic technology and data point models[67]	Technology that converts regulatory text into programming language	Machine-readable regulations for faster and low cost adaptation to changes in regulations	FCA plans to develop machine readable regulations.[68]

[58] See Section 5.5: Predictive and Algorithmic Supervision, Definition combined from FSB (2017) *Artificial Intelligence and Machine Learning In Financial Services,* available at https://bit.ly/2h1h8UT; Rodriguez, J (2017) *Types of Artificial Intelligence Learning Models,* available at https://bit.ly/2qpDQeq

[59] See Exhibit 12: Singapore – MAS Uses Data Science and Machine Learning

[60] IIF (2016) *Regtech in Financial Services: Technology Solutions for Compliance and Reporting,* available at https://goo.gl/A62STL

[61] See Annex D: Regtech Use by the BSP

[62] Toronto Center (2017) *FinTech, Regtech and SupTech: What They Mean for Financial Supervision*, available at https://goo.gl/R3vWxH

[63] See Annex F: Regtech Use by CBN, Rinaldi, A (2015) *Biometrics' New Identity – Measuring More Physical And Biological Traits,* available at https://bit.ly/2CYBKdI

[64] See Annex F: Regtech Use by the CBN

[65] Microsoft Azure (2018) *What Is Cloud Computing?,* available at https://bit.ly/2oIZmu4; IBM (2018) *What is cloud computing?,* available at https://ibm.co/2Fxo2vr

[66] See Section 5.4: Access to New Flows of Information, World Bank Group (2018) *Blockchain & Distributed Ledger Technology (DLT),* available at https://bit.ly/2yvQHzS; FCA (2016) *Feedback Statement Call for Input On Supporting the Development and Adopters of Regtech*, available at https://bit.ly/2bXLSrg

[67] See Section 5.6: Machine Readable Regulations, FCA (2016) *ibid.*

[68] See Exhibit 13: UK FCA and Machine Readable Regulations

Shared Utilities[69]	Central repository that allows involved parties in the industry to share services	KYC[70] utilities consolidate CDD[71] data and reduce duplication.	MyInfo in Singapore is a KYC utility.[72]

Exhibit 2: Key Technologies driving regtech innovation[73] along with definitions and an example of impact on regulators/regulatory processes.

2.2. Regtech for Market Participants

Financial Institutions: Governments and international bodies brought about major regulatory changes that increased capital requirements and compliance costs for FIs after the global financial crisis (GFC) of 2008.[74] The G20 in 2009 established a financial SSB, the Financial Stability Board to play a key role in promoting the reform of international financial regulation and monitoring the international financial system for any signs of systemic weakness.[75]

FIs around the globe struggled to different degrees post-GFC with increased compliance burdens and monitoring and restrictions on investments, which catalyzed the need for development and adoption of regtech as means to reduce the cost of compliance and to manage risk.[76] Uncoordinated timelines and agendas for the implementation of overlapping regulations and constant evolution of regulation[77] furthered costs and complexities.[78] This, coupled with the lack of trust in the financial system led banks in developed countries to become more hesitant to providing credit and maintaining relationships that provided low returns and higher risks. Many developing countries were affected by this credit-freeze and low risk appetite.[79] This affected trade, remittance flows, aid and capital inflows in developing countries.[80]

DFSPs: While increased regulation for banks limited their scope but allowed less regulated non-bank DFSPs to grow.[81] In developing countries, growth of DFS targeted and still targets financial inclusion and economic

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[69] See Section 7.2: Shared Utilities as Regtech, FCA (2016) *Feedback Statement Call for Input on Supporting the Development and Adopters of Regtech*, available at https://bit.ly/2bXLSrg

[70] Know Your Customer (KYC)

[71] Customer Due Diligence (CDD)

[72] See Exhibit 15: Singapore – MyInfo KYC Utility

[73] Data sourced from author research, and Ramachandran, V & Woodsome, J (2018) *Fixing AML: Can New Technology Help Address the De-risking Dilemma?,* available at https://bit.ly/2IKMECI; KPMG (2017) *The Nexus Between Regulation And Technology Innovation,* available at https://bit.ly/2q61nBO; FCA (2016) *Feedback Statement Call For Input On Supporting The Development And Adopters Of Regtech*, available at https://bit.ly/2bXLSrg; Toronto Center (2017) *FinTech, Regtech and SupTech: What They Mean for Financial Supervision*, available at https://goo.gl/R3vWxH; Deloitte (2017) *The Regtech Universe On The Rise*, available at https://goo.gl/LUpKtH

[74] IFC (2016) *De-risking by Banks in Emerging Markets- Effects and Responses for Trade*, available at https://bit.ly/2JGkj1p

[75] The Board includes all G20 major economies, Financial Stability Forum members, and the European Commission. It is hosted and funded by the BIS and is based in Switzerland. See FSB (2018) Our History, available at http://www.fsb.org/about/history/

[76] Eyers, J (2016) *Welcome to the new world of 'regtech'*, available at https://bit.ly/2dAH5Dz

[77] On average, 201 regulatory alerts daily. Hill, E (2016) *Is Regtech The Answer To The Rising Cost Of Compliance?*, available at https://bit.ly/2q6CBAn

[78] CB Insights (2018) *The Evolution of Regtech and the Future of Regulatory Compliance*, available at https://bit.ly/2EH9hG7

[79] See Section 2: The Case for Regtech/Evolution of Regtech, IFC (2016) *De-risking by Banks in Emerging Markets- Effects and Responses for Trade,* available at https://bit.ly/2JGkj1p

[80] Chappell, L & Dolphin, T (2010) *The Effect of the Global Financial Crisis on Emerging and Developing Economies*, available at https://bit.ly/2qpO6CQ

[81] IFC (2017) *Digital Financial Services: Challenges and Opportunities for Emerging Market Banks*, available at https://bit.ly/2wAEqq8

development.[82] Rapid pace of DFS innovation and introduction of new customers and providers in the market, however, gives rise to newer risks. Risks related to data privacy and consumer protection can be more pronounced in developing countries due to low financial literacy, lack of appropriate policies and regulations, underdeveloped technology ecosystem and weak infrastructure.[83]

Compliance burdens are especially heightened in the provision of DFS where multiple regulators including financial and telecommunication regulators are involved, leading to duplication in DFS reporting requirements within the same authority and for multiple authorities.[84] DFSPs may need to invest time, skill and money into compliance activities which can be difficult if they have limited resources. Such compliance burden could force DFSPs to compromise on innovation.

A common response to high compliance burdens has been to increase the size of FI's risk management and compliance teams.[85] While this may be a solution for some, it may not be feasible for smaller DFSPs - usually start-ups - with limited financial and human resources. DFSPs can adopt cost cutting regtech solutions, either developed in-house or by TSPs, that tackle different aspects of regulatory issues.[86] These include issues related to market and

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[82] CGAP (2018) *Digital Financial Services*, available at https://bit.ly/1RrXkXY

[83] See Section 6.7: Security, IFC (2017) *Digital Financial Services: Challenges and Opportunities for Emerging Market Banks*, available at https://bit.ly/2wAEqq8; USAID (2016) *Understanding the Risks of Digital Financial Services,* available at https://bit.ly/2IQW1Ro; Arenaza, S (2014) *Potential Risks To Clients When Using Digital Financial Services,* available at https://bit.ly/1z8W5AX

[84] Toronto Center (2017) *FinTech, Regtech and SupTech: What They Mean for Financial Supervision*, available at https://goo.gl/R3vWxH

[85] Around 10-15% of the workforce is dedicated to governance, risk management and compliance. Deloitte (2017) *The Regtech Universe On the Rise*, available at https://goo.gl/LUpKtH

[86] See Exhibit 2: Key Technologies in Regtech Innovation, Petrasic, K (2016) *Regtech Rising: Automating Regulation for Financial Institutions,* available at https://bit.ly/2rhI1cL

staff surveillance, reporting, anti-money laundering/combating the financing of terrorism (AML/CFT),[87] know your customer (KYC),[88] customer due diligence (CDD)[89], and risk management.[90]

The gap between DFSPs and regulatory requirements may be bridged by regtech and in the process, it can increase access to underserved populations.[91]

2.3. Regtech for Regulators

Unlike legacy technologies[92] and associated manual processes that have been used by regulators for their own internal assessments and supervisory remits, regtech can facilitate the collection and organizing of high velocity, diverse types and large volumes of data in agile, fast and integrated ways to facilitate automated extraction of

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[87] Standards to manage money laundering and terrorist financing risks for financial institutions. Money laundering refers to the conversion or transfer of property or any association, knowing it is derived from criminal activity, for the purpose of hiding its origins, nature, location, disposition, movement, ownership. Similarly, financing of terrorism is the provision or collection of funds to contribute to the commission of specific offences while in complete knowledge that they are being used or will be used for such purposes. Summarized from European Investment Bank Group (2018) *Anti-Money Laundering and Combating Financing of Terrorism Framework,* available at https://bit.ly/2HX4QMH; CGAP (2005) *AML/CFT Regulation,* available at http://www.cgap.org/publications/amlcft-regulation; IMF (2018) *Anti-Money Laundering/ Combating the Financing of Terrorism (AML/CFT)*, available at https://www.imf.org/external/np/leg/amlcft/eng/

[88] ACAMS defines KYC as: 'AML policies and procedures used to determine the true identity of a customer and the type of activity that is "normal and expected," and to detect activity that is "unusual" for a particular customer.' ACAMS (2018) *AML Glossary of Terms*, available at https://www.acams.org/aml-glossary/. Although FATF largely discarded the term 'KYC' in its documents onwards from 2003, KYC is still widely used and is now considered to be only but one – the identity input – component of a CIV procedure that, in turn, is part of the ongoing CDD process. Perlman, L & Gurung, N (2018) *The Use of eIDs and eKYC for Customer Identity and Verification in Developing Countries: Progress and Challenges,* available at www.dfsobservatory.com

[89] ACAMS defines CDD in terms of ML controls, as requiring 'policies, practices and procedures that enable a financial institution to predict with relative certainty the types of transactions in which the customer is likely to engage. CDD includes not only establishing the identity of customers, but also establishing a baseline of account activity to identify those transactions that do not conform to normal or expected transactions.' As part of CDD, providers it says should identify and verify the customer's identity using reliable and independent sources; identify and verify the beneficial owner so as to know whether they are the actual parties of interest; obtain information on the purpose and intended nature of the business relationship; assess the risks associated with the business relationship; monitor transaction to check if it is consistent with the knowledge of the customer, their business and risk profile and conduct ongoing due diligence. FATF (2012) *The FATF Recommendations,* available at https://bit.ly/1e7w0Gl. Similarly, but in the context of financial inclusion, CGAP says CDD 'involves identifying a client and verifying the client's identity by checking his or her identity documentation or data and, where appropriate, conducting background and beneficial ownership checks. Clients are then profiled and their transactions are monitored to identify discrepancies that may trigger a suspicious transaction report to be filed with the country's FIU.' See Lyman, T & de Koker, L (2018) *KYC Utilities & Beyond: Solutions for AML/CFT Paradox?*, available at https://bit.ly/2OqOgso.

[90] PwC (2017) *Get Ready for Regtech,* available at https://pwc.to/2JSDZyH; Bryans, T (2017) *The Rise of Regtech and the Impact on Compliance*, available at http://www.corporatecomplianceinsights.com/the-rise-of-regtech/; Schutzer, D (2017) *Regtech: Innovation and the Future of Financial Servi*ces, available at https://bit.ly/2udvar1

[91] Wakefield, N (2017) *How Technology Is Driving Financial Inclusion*, available at https://bit.ly/2HuHxH3

[92] Older technologies related to previous or outdated systems. They can include reporting using excel and XML templates, emails, CDs, and paper by market participants to the central bank and recording and storing information in excel spreadsheets by central banks. Legacy technologies may allow for sufficient support to run central bank operations but may be insufficient to allow them to scale and adapt to the changing financial sector. Summarized based on conversation with RBI, NRB, CNVB, and information from Mann, P (2017) *Regtech: The Emergence of the Next Big Disruptor*, available at https://internationalbanker.com/finance/regtech-emergence-next-big-disruptor/; Schneider, A (2013) *When Companies Become Prisoners of Legacy Systems,* available at https://bit.ly/1LJYxZH

actionable data.[93] A key attribute of regtech is the 'check' function, which acts as a feedback loop to determine whether reports have been submitted on time, accurately, in the correct format and to the correct supervisor.

Supervisory functions: Regulators may require financial and operational data from market participants to produce statistics that drive their understanding of the market and policy decisions. Some types of data collected by central banks and other DFS supervisors include:[94]

- Financial statements (balance sheet, cash flow, income statement)
- Financial ratios (liquidity ratios, capital adequacy ratios)
- Volume and value of transactions
- Number of transaction points
- Number of accounts and total balances
- Description of frauds and actions taken, actions taken on consumer complaints, risk management practices and IT systems
- Losses from frauds, consumer compensations

With the adoption of regtech by market participants, they may be able to report data more frequently, monthly, daily or even real-time, making large amounts of data accessible to regulators.[95] Regulators may then be able to use regtech to process and analyze the data.

Internal Processes: For central banks specifically, regtech can potentially improve efficiency and effectiveness of their internal processes as well as external processes involving both the supervised entities and the central bank.[96]

Regtech has assisted central banks to address the challenges of monitoring a rapidly evolving financial sector that lacks proper tools and infrastructure for supervision and monitoring[97] by providing alternative processes.[98] It may also allow central banks to develop appropriate regulations, by facilitating better understanding of new market participants and technologies. Many central banks in developing countries however face unique challenges[99] that may hinder the adoption of regtech. Without regtech central banks may not have the capacity to monitor the new additions to the financial system. So they are more likely to impose stricter regulations to deal with the new and unknown risks posed by the changing financial landscape. DFSPs could hence face regulatory uncertainties and compliance burdens as central banks try to balance innovation and stability.[100]

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[93] Mann, P (2017) *Regtech: The Emergence of the Next Big Disruptor*, available at https://bit.ly/2gFm2XL; Deloitte (2017) *Regtech is the new FinTech,* available at https://bit.ly/2IetXui

[94] Dias, D & Staschen, S (2017) *Data Collection by Supervisors of Digital Financial Services,* available at https://bit.ly/2LCbTMB

[95] See Section 5.3: Collection of Granular Data, Section 5.4: Access New Flows of Information

[96] See Section 5: Emerging Use Cases for Regtech

[97] Arner, D, Barberis, J & Buckley, R (2017) *FinTech and Regtech in a Nutshell, and the Future in a Sandbox*, available at https://cfa.is/2POCyVl

[98] See Exhibit 14: Summary of Regtech Use Cases, Section 5: Emerging Use Cases for Regtech

[99] See Section 7: Regtech for Financial Inclusion

[100] Castri, S & Plaitakis, A (2017) *What's Next for Financial Technology Innovation*, available at https://bit.ly/2BtBgrL

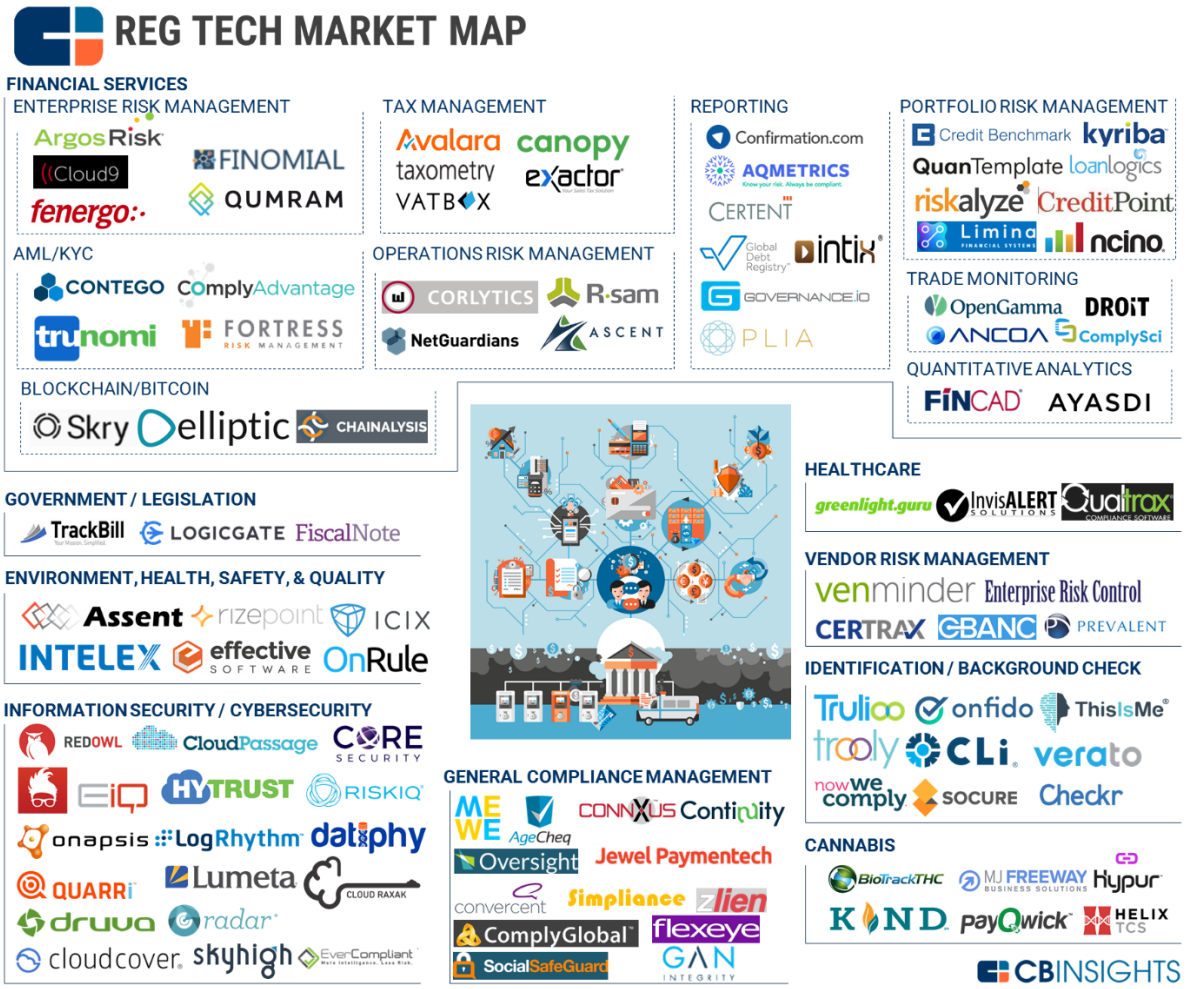

Exhibit 3: Regtech Market Map. Regtech providers addressing issues in a wide range of industries apart from financial service including government/legislation, healthcare, environment, health, safety and quality, vendor risk management, information security/cyber security, identification/ background check, cannabis and general compliance management. This represents the ecosystem as of 2017. [101]

3. Regtech Development

3.1. Overview

Development of effective regtech solutions is often achieved through collaboration between multiple parties. Collaboration is key in developing cost effective and efficient solutions. Collaborative initiatives such as regulatory sandboxes[102] are emerging in different parts of the world with objectives to promote innovation in the field while minimizing risks.

[101] CB Insights (2017) *Regtech Market Map: The Startups Helping Businesses Mitigate Risk and Monitor Compliance Across Industries*, available at https://goo.gl/AV9dn4

[102] See Exhibit 6: Regulatory Sandboxes and their Role in Regtech

Emerging participants in regetch solution development that impact central bank competencies and remits are – either together or separately – central banks,[103] market participants,[104] technical solution providers (TSP), [105] consultants,[106] and donors.[107]

Within central banks, innovation may be initiated by in-house IT, compliance and Management Information Systems (MIS) divisions, or serviced by external TSPs.[108] Consultants are often also involved in the process, filling in the human and financial resource gaps if they exist.[109] And an emerging trend in the developing world is the catalytic role of donors[110] who provide capital for initiating the scoping, then development and technology solution phases.

3.2. Primary Actors in Regtech Development

A. Support Systems

3.2.1. Donors

Donors[111] often provide financial resources and direct technical assistance to drive innovation where other private capital is not available and can promote awareness of regtech especially in isolated developing countries.[112]

Even with increased funding for regtech, there are still major operational challenges in implementing regtech solutions. In particular, regtech solutions have a high upfront cost and also a long procurement process.[113] So even if the regulators have resources, deployment of budget, to procure, implement, and operationalize solutions may be slow. And with few well-developed regtech success stories, it is difficult to convince higher authorities within a central bank to adopt regtech.[114] Under such circumstances, donors play a huge role in initiating the development processes and obtaining buy-in and mindshare from regulators and industry alike. They usually have constant contact with regulators, either through country missions, workshops and webinars, conferences.

USAID is a major donor for regtech projects to increase the capacity of regulators in developing countries.[115] In 2016 it funded regtech consultants, Regtech for Regulators Accelerator (R2A)[116] for a total investment of USD 2.8 million, along with the Bill and Melinda Gates Foundation[117] and the Omidyar Network.[118]

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[103] See Section 3.2.5: Central Banks

[104] See Section 3.2.4: Market Participants

[105] See Section 3.2.3: Technology Solution Providers

[106] See Section 3.2.2: Consultants

[107] See Section 3.2.1: Donors

[108] Sullivan, M (2017) *Banks Rise to The Fintech Challenge- Bringing Disruption In-House*, available at https://ibm.co/2kEyRpR

[109] Based on conversations with USAID, RBI, CNBV

[110] See Exhibit 5 for donors current participating in regtech development and implementation.

[111] See Exhibit 5 for a comparative description of participants in the regtech development ecosystem.

[112] Based on conversation with USAID

[113] Innovate Finance (2017) *Keynote Address by Jonah Crane*, available at https://goo.gl/ZKNcZx

[114] Based on conversation with USAID, RBI

[115] USAID (2018) *Regtech*, available at https://partnerships.usaid.gov/partnership/regtech

[116] See Exhibit 4: R2A Accelerator

[117] Bill & Melinda Gates Foundation (2018) *Bill & Melinda Gates Foundation,* available at https://www.gatesfoundation.org/

[118] Omidyar Network (2018) *Omidyar Network,* available at https://www.omidyar.com/

3.2.2. Consultants

Regulators often lack capacity to engage in regtech projects.[119] Consultants are critical components of regtech projects, *inter alia*, finding capacity gaps that regtech can potentially fill and assisting in technical training for both regulators and businesses.[120] In this context, they may fill the knowledge gap of regulators to develop regtech solutions.

For example, the Rockefeller Philanthropy Advisors (RPA)[121] and Bankable Frontier Associates Global (BFAG),[122] assiated donors in formulating and implementing a strategy for the R2A initiative in Philippines and Mexico.[123] The consultants aim to guide regulators through the problem identification process, and where possible, to assist in implementation of solutions.[124] Since the regulators were able to distinguish their problems but did not have a solution, R2A designed a 'hackathon'[125] to identify a suitable solution and capable TSP for the regulator.[126] Consultants hence structure the ideation process as for the context, capacity, budget and needs of the regulators.

It is important for consultants to outline a specific project charter that details the roles, responsibilities and expectations of the involved parties,[127] as ultimately the success of the initiative depends on each of the parties fulfilling their responsibilities.

3.2.3. Technology Solution Providers

TSPs are third party entities – sometimes startups – that provide regtech solutions, products and services.[128] With the rapid changes in IT, limited IT skills and resources of regulators and vast knowledge of regtech/IT systems, TSPs can contribute to a regulator's decision to contract regtech to TSPs.

Outsourcing can, however introduce, among many, operational risks and responsibilities for the regulator (and the TSP), for example having to apply additional resources to monitor the progress of TSP and to maintain contractual relationships.[129] Implementation of proper controls such as service level agreements (SLAs),[130] governance and monitoring of TSP, and evaluation of the TSP's internal and security controls can help mitigate risk.[131]

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[119] See Section 6.4.2: Capacity of Regulators

[120] Akers, H (2018) *What Is A Professional Consultant?*, available at https://bit.ly/2JNUADE

[121] RPA (2018) *Rockefeller Philanthropy Advisors,* available at http://www.rockpa.org/

[122] BFA (2018) *Regtech for Regulators Accelerator,* available at http://bfaglobal.com/projects/r2a/

[123] See Exhibit 5: Key Regtech Ecosystem Participants, Exhibit 4: R2A Accelerator

[124] Based on conversation with USAID, CNBV

[125] Hackathon is an event of a particular duration that allows interest parties to collaboratively solve problem(s) in creative ways. Grijpink, F, Lau, A & Vara, J (2015) *Demystifying The Hackathon,* available at https://mck.co/2rizvtq; Tauberer, J (2018) *How to Run a Successful Hackathon,* available at https://hackathon.guide/

[126] See Exhibit 4: R2A Accelerator

[127] Based on conversation with USAID, CNBV

[128] See Exhibit 5: Key Regtech Ecosystem Participants, OCC (2012) *FFIEC IT Examination Handbook Booklet Revision and Administrative Guidelines for Interagency Supervisory Programs,* available at https://bit.ly/2v8AXU7

[129] Deloitte (2012) *4 IT Outsourcing Risks and How to Mitigate Them*, available at https://bit.ly/2v6w9i6

[130] A commitment between the service provider and the service user that outlines the service expected from the service provider. It includes terms with regards to quality, availability, responsibilities as well as remedies or penalties in case the agreed-on service levels are not met. Greiner, L, Overby, S & Paul, L (2017) *What Is SLA? Best Practices for Service-Level Agreements,* available at https://bit.ly/2qqVQV7

[131] ISACA (2013) *Risk & Control Considerations for Outsourced IT Operations,* available at https://bit.ly/2R91sPG; FFIEC (2018) *General Control Environment of the Service Provider,* available at https://bit.ly/2HMwFaX; Association of International Certified Professional Accountants (2015) *COSO: Internal Control a Challenge with Outsourced Providers,* available at https://bit.ly/2JCAahA

The number of TSPs offering regtech solutions is growing rapidly: the 2017 Global Regtech Review Report analyzed 416 regtech companies, serving not only central banks. Around 44% addressed AML and Customer Identification and Verification (CIV) procedures that are major areas of concern for developing countries with lack of proper ID systems.[132] Another study of 150 regtech companies showed solutions for categories of regulatory reporting, risk management, identity management and control, compliance and transaction monitoring.[133] Examples of regtech innovations are shown in Exhibit 2 and Exhibit 14.

Some of the regtech solutions permeating the market are derived from existing fintech solutions, now adapted for compliance and suptech-type regtech application. Many of the newer, more innovative solutions though cannot be cut 'n paste from other ecosystems: TSPs will invariably need to create fit-for-purpose prototypes so that regulators can see what is possible and to augment capabilities.

While some innovator offerings may provide pathways for regulators to understand the potential technology availability, in many cases the TSPs we surveyed indicate that the more innovative solutions may be 'hidden' from regulator view because of the limited capacity of especially startup-level innovators to market their offerings to audiences across borders. They may also be handicapped by an inability to pass boilerplate government procurement criteria because they may be new to the market and do not have an extensive support network or client list as referrals. It may take the intervention of specific personnel – 'regtech champions' – who understand the fundamental need for a particular solution to overcome these procurement handicaps.

More fundamentally though, to sustain their existence, innovators will need to scale their offerings in so far as they will develop and provide regtech services not necessarily for just one department in one central bank, but to many regulators in a country or region as part of a global 'suptech' or regtech standardization effort. Regulators also need to standardize policies related to specific needs[134] such that TSPs will then be able to design appropriate, standardized solutions.

Launched in 2016, the donor-backed R2A partnered with selected financial authorities in Philippines, Ghana[135] and Mexico to develop tools and techniques for better market supervision and policy analysis. They provided a structured approach to foster collaboration between financial authorities and TSPs to prototype solutions based on technology and data that address key challenges faced by financial authorities.

This initiative is funded by the Bill & Melinda Gates Foundation, Omidyar Network and USAID and is managed by BFA global with RPA as fiscal sponsor.

A hackathon was initiated in the respective jurisdictions to find a TSP with idea and skills that best fit the needs of the financial authority. A USD 100,000 prize was awarded to a TSP to develop and test a regtech prototype. This has relieved regulators from the process of obtaining initial internal funding to start national regtech initiatives. The regtech prototype will replace or improve labor-intensive and rigid models such as manual reporting with automated approaches that harness new data-focused technologies. Once the prototype is tested, regulators will be able to better evaluate the need of the regtech solution and make a better case for investment from the government.

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[132] FinTech Global (2017) *Over Half of All Regtech Companies Address AML or KYC Regulation,* available at https://bit.ly/2kTblGt

[133] Deloitte (2017) *The Regtech Universe On the Rise*, available at https://goo.gl/LUpKtH

[134] This may also include the need to create specific data templates.

[135] The R2A Ghanaian regtech imitative has reportedly been suspended.

Exhibit 4: Regtech Activities of the 'Regtech for Regulators Accelerator' (R2A).[136]

B. Supervised Entities

3.2.4. Market Participants

Market participants, such as FIs and DFSPs use regtech solutions for their own internal – mainly compliance – processes or mandated by regulators to support the regulator's regtech initiative.

Emerging regtech solutions offer market participants opportunities to gather large volumes of data, extract meaning from them, streamline reporting and to generally be able to expedite compliance processes.[137] It may also assist them in being compliant with AML/CFT regulations by using better CIV systems along with predictive monitoring of transactions.[138] For large FIs, regtech could provide opportunities to identify areas impacted by recent changes in regulations, allowing them to be contemporaneous with regulatory practices and requirements.[139] Benefits of regtech then can expand beyond reduction of cost to increasing scalability, flexibility, security and growth for market participants.

They may however find adoption challenging, especially when they are expected to update their processes or IT systems beyond their capacity to ensure that they are aligned with the externally-focused regtech solutions of regulators. The unexplored limitations of market participants may influence regtech adoption by regulators, since adoption by market participants play a crucial role in determining the success of the regulator's regtech initiative. If the central bank, for example, replaces manual reporting of compliance data using excel templates with an automated portal which includes data validation and analysis as part of their regtech initiative, without the use of the portal by market participants, the regtech solution will not be able to collect, automatically validate and analyze data for the central bank. Ultimately, for suptech purposes, regtech solutions must be collaborative and collegial.

C. Regulators

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[136] Regtech for Regulators Accelerator (2018) *What is R2A?,* available at https://www.r2accelerator.org/about-r2a/

[137] Alvarez, C (2017) *How Does Regtech Help Banks Comply To Regulations?,* available at https://bbva.info/2EFTGWE

[138] Wright, M (2017) *Big Data and Regtech Team Up in The Fight Against Financial Crime*, available at https://goo.gl/bq4JmU

[139] Alvarez, C (2017) *How Does Regtech Help Banks Comply To Regulations?*, available at https://bbva.info/2EFTGWE

3.2.5. Central Banks

Regulators are not just consumers of regtech-derived data, but may play multiple other roles in the regtech ecosystem such as acting in a facilitative and catalytic role in development of regtech solutions.[140]

Despite slower regtech adoption by central banks compared to many of their supervised entities (for compliance), [141] there are immense advantages of adoption for central banks. These include cost and time savings from automation,[142] real time monitoring and fraud detection,[143] flexibility in analysis of raw data,[144] access to new flows of information,[145] proper implementation of rules,[146] and integration of processes[147] for better supervision.

Regtech solutions used by central banks predominantly focus on digitization of existing processes but there are other innovative technologies such as Artificial Intelligence (AI), machine learning, big data analytics, Distributed Ledger Technology (DLT), biometrics, and cloud computing which can completely change the nature of supervision by introducing new and advanced monitoring techniques.[148]

To incentivize innovation, regulators need to provide a strong business case for TSPs to pour often limited resources into developing and maintaining fit-for-purpose regtech solutions. This could include regulators standardizing regtech solutions, whilst embracing the syntax and semantics of variable solutions, providing opportunities for TSPs – some of whom may have grand innovations, but may be cash-starved startups – to scale their regtech solutions across jurisdictions and/or industries.[149]

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[140] See Exhibit 5: Key Regtech Ecosystem Participants

[141] Lee, H, Pestrasic, K & Saul, B (2016) *Regtech Rising: Automating Regulation for Financial Institutions*, available at https://bit.ly/2KAB8LQ; Arner, D, Barberis, J & Buckely, R (2018) *Fintech, Regtech And The Reconceptualization Of Financial Regulation,* available at https://bit.ly/2I9mNaO

[142] See Section 5.2: Automates Report Submission and Data Quality Management

[143] See Section 5.5: Predictive and Algorithmic Supervision

[144] See Section 5.3: Collection of Granular Data

[145] See Section 5:4: Access to New Flows of Information

[146] See Section 5.6: Machine Readable Regulations

[147] See Section 5.7: Improvement and Integration of Internal Processes

[148] See Exhibit 2: Key Technologies in Regtech Innovation, Exhibit 14: Summary of Regtech Use Cases

[149] See Section 4.3: Business Case for Solution Development

Ecosystem Participants	Examples	Potential Roles
Financial Regulators[150]	● Central Banks	● Use regtech to improve their supervisory processes ● Facilitate developments in the industry ● Supervise technology providers ● Foster collaboration across the regtech ecosystem ● Create rules and processes to encourage and guide innovation and engagement
Technology Service Providers (TSP)[151]	● Vizor[152] ● BearingPoint[153]	● Understand the regulatory and business frameworks in order to develop innovative solutions that align with the regulatory challenges faced by regulators and market participants
Market Participants[154]	● FI ● Fintechs ● PSP[155] ● DFSP ● MNO	● Use regtech to improve their regulatory and compliance processes ● In-house development of regtech solutions or outsource development to TSP ● Comply with regulatory requirements laid out by regulators (for example, regulatory reporting using IT processes outlined by the regulator)
Consultants[156]	● BFA Global ● R2A ● RPA[157] ● MM4P[158], UNCDF[159] ● UNDP	● Provide expert advice for ideation, development, and/or implementation of regtech solutions
Donors[160]	● USAID[161], Bill & Melinda Gates Foundation, Omidyar Network; UNDP	● Provide financial resources to initiate or continue regtech initiatives

Exhibit 5: Key Regtech Ecosystem Participants

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[150] Toronto Center (2017) *FinTech, Regtech and SupTech: What They Mean for Financial Supervision*, available at https://goo.gl/R3vWxH

[151] Also referred to as Regtech provider and Regtech companies, are third-party that provides technology services including software and network development, integration and maintenance, information security, mobile services, web applications to regulated entities. CBInsights (2017) *Regtech Market Map: The Startups Helping Businesses Mitigate Risk and Monitor Compliance Across Industries,* available at https://bit.ly/2joDktw; Roland Berger (2017) *Central banking IT of the future,* available at https://bit.ly/2KBcniG

[152] See Exhibit 14: Summary of Regtech Use Cases, Vizor (2018) *Vizor,* available at https://vizorsoftware.com/

[153] See Exhibit 9: Austria – OeNB collects Granular Data Using AuRep, BearingPoint (2018) *BearingPoint,* available at https://www.bearingpoint.com/en-us/

[154] Used interchangeably with regulated entities

[155] Payment Service Providers (PSP). They may be defined in different manner by different regulators. The FCA considers PSPs to be persons which are listed in a specific list that include authorized payment institution, small payment institution, and electronic money issuer, that carry out a payment service. More information on list of included persons can be found in the FCA Handbook. FCA (2018) *Payment Service Provider,* available at https://www.handbook.fca.org.uk/handbook/glossary/G2619.html

[156] See Section 3.2.2. Consultants

[157] Regtech for Regulators (R2A)

[158] Mobile Money for the Poor (MM4P)

[159] United National Capital Development Fund (UNCDF)

[160] See Section 3.2.1. Donors

[161] United States Agency for International Development (USAID)

Successful regtech development and implementation, however, requires proper planning and the collaborative efforts of multiple ecosystem players.[162]

A proposed iterative process for undertaking a 'soup-to-nuts' needs assessment and for the development of specific regtech solutions for regulators – and central banks in particular – is outlined in the conceptual development framework outlined in Annex H.

3.3. Methodologies for Regtech Development and Implementation

3.3.1. Overview

Devising technical solutions for implementation as a 'regtech' solution is not simply a matter of embracing 'off-the-shelf solutions' or the latest technical innovation from vendors who 'pitch' to regulators. It is also not upgrading to the latest version of Excel. Rather, it starts with and requires an enterprise-wide view of the regulators policies, internal supervisory processes, internal procurement processes, and capacity to perform required tasks such as devise a Request for Information (RFI) for TSPs; to assess the technical feasibility of any responses; to operationalize the chosen regtech solution; and then to analyze any data received. Limited regtech expertise and financial and human capital within the central banks can, however, pose significant challenges in development.[163]

A. Development Phases

3.3.2. Needs Assessment

The case to adopt regtech can be fueled by a clear regulatory objective, for example, reducing compliance burdens while increasing regulatory reporting frequency, or a desire to develop tools to implement and/or supervise a regulatory policy.[164] Adopting new technology, however, can also precipitate policy, as was the case in Nepal, where the collection of geospatial data of financial access points such as bank branches and agents to further financial inclusion policies identified the need for policy on how many agents should be present in each location for effective implementation of financial inclusion policies.[165]

Central banks may conduct interviews, surveys, workshops internally amongst the different departments or externally with market participants to assess priorities and needs.[166] A cloud-based survey across the entity may ventilate what pain points need solutions, followed by the creation of specific working groups to engage with management and industry groups to collect and analyze information. The findings may be evaluated to select a specific problem to address the desired outcome and the ability of a regtech solution to address and solve pain points.

3.3.3. Development Strategy

Central banks should assess the building blocks for a regtech program. This may include designing a roadmap for next 3-5 years along with industry and supervised institutions.[167] Once this is done, workgroups could be established to action the roadmap, to calibrate needs versus capacity and to develop timeframes for availability of a solution for the identified need(s).

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[162] See Exhibit 5: Key Regtech Ecosystem Participants, Section 3: Regtech Development, Section 4: Factors in Regtech Development and Use

[163] See Section 6.4: Capacity, Section 6.5: Procurement

[164] See Exhibit 14: Summary of Regtech Use Cases

[165] See Section 7.1: Overview, Annex G: Regtech Use by the NRB

[166] University of Minnesota (2018) *Conducting a Needs Assessment,* available at https://cyfar.org/ilm_1_9

[167] Federal Agencies Digitization Guidelines Initiative (2009) *Digitization Activities, Project Planning and Management Outline,* available at https://bit.ly/2rhDzda

Some general points to consider while developing the strategy include:

- Does the central bank has the required capacity to identify and then supervise development of a solution?
- Who will be involved in the process?
- The roles and responsibilities of the involved parties
- How long will process take?
- How much will it cost?
- Who will pay for it?
- How will it replace or integrate with legacy systems?

3.3.4. Internal Capacity for Assessment, Execution and Operationalization

Implementing the agreed regtech strategy requires adequate skills to initiate, assess, execute and operationalize each phase of the regtech development process. A core group of staff with basic awareness of the processes of the central bank, experience with project management, technical expertise and decision making authority should be formed to initiate the process.

Additional working groups can complement the core by managing specific stages of the development process. That is, needs assessment, procurement, development, and adoption. The core people – as well as each working group – should have the capacity to perform their tasks as well as collaborate with others. The required capacity however, may not always be available internally, in which case external support – technical assistance from donors and consultants - can be sought.

3.3.5. Procurement

Generally, procurement process involves but may not be limited to publishing a RFI, followed by a RFP to gather information on interested TSP; the services they have provided (and can provide); as well as the price for their services.[168] Scorecards, assessment criteria and other tools for assessing submissions may standardize the evaluation process and help identify the TSP with the best services at a competitive price.[169] Newer technologies such as machine readable PDF files[170] can also be used to simplify the evaluation process.

Central banks can create alliances with other central banks as part of the procurement process to share insights on available technologies and efficient development processes and to organize collaborative workshops such as the TechSprint by the UK Financial conduct Authority (FCA), where established players, new fintech companies and regulators worked together to understand the potential of regtech and find efficient and effective solutions.[171]

3.3.6. Development

As each jurisdiction may have specific needs, initially the central banks along with a development agency and donor could catalyze development of a regtech solution by promoting a local innovation hub, similar to the business model of R2A.[172] The hub can encourage collaboration between the TSP and the regulators such that both parties understand the technology, the pain points it is trying to address and the context in which it will be adopted.

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[168] Trade Ready (2017) *The 7 Steps of A Strategic Procurement Process*, available at https://bit.ly/2reHIPc

[169] World Bank (2016) *Use of Evaluation Criteria for Procurement of Goods, Works, and Non-Consulting Services Using RFB and RFP,* available at https://bit.ly/2FGOD8X

[170] That is, where the PDF file is not a flat image file, but rather allows selection (and copying) of any text within the PDF file.

[171] See Section 4: Factors in Regtech Development and Use, Exhibit 7, MAS and FS-ISAC Collaborate for Cybersecurity Information Sharing, Exhibit 8: Collaborative Efforts of the UK Financial Conduct Authority (FCA), Exhibit 13: UK FCA and Machine Readable Regulations

[172] See Exhibit 4: R2A Accelerator

Collaboration between involved parties is also key in devising and conducting a proper governance process with 3-month reporting based on the agreed upon development timeline and expected deliverables to measure whether sufficient progress has been made.

Regtech solutions can also be discovered from implementation of a regulatory sandbox program that curates innovative regtech and other fintech solutions. [173] Testing using sandboxes can allow regulators and developers to closely monitor the impact of regtech before it is widely adopted in the ecosystem.[174] Potential users use and test the prototype or professional testers may be hired. Regardless of the testing approaches, the feedback on the prototypes may then be used to further develop, test and evaluate the solution.

Following the completion of testing, central banks scout and evaluate opportunities to scale the technology and based on feasibility, could implement it. The development process is then followed by the adoption process which may include complete integration of the regtech solution into the existing systems and processes of the respective ecosystem players, use of the regtech for the intended purpose, and close monitoring of its effectiveness.

4. Factors in Regtech Development and Use

A. National Collaboration

4.1. Collaboration Between Industry, Ecosystem Participants, and Regulators

Compliance and reporting ultimately has a consumer and supplier: the central bank and the supervised entities, respectively. Facilitating the technology development and possibly also playing an operational role are TSPs and, to some degree, ecosystem participants. [175]

Each of these ecosystem participants have their own roles, but knowledge-sharing amongst them is important for regtech development since this approach helps to understand and address nuances of hidden challenges, determine appropriate tools, and develop contextual solutions.[176] Since the success of regtech solutions are dependent on their integration into the appropriate ecosystem, regtech innovation, - even though primarily led by TSPs - can be catalyzed by the capabilities of the industry and the regulator's risk preferences.[177]

Regtech solutions hence may need to integrate with the systems used by market participants to harness these efficiencies. Because these usually vary, solutions should be developed with the objectives and capacity of the regulator and market participants in mind, while meeting regulatory requirements for privacy and cyber security. Collaboration is necessary to understand such issues and ultimately develop cooperative regtech solutions. Not just external collaboration amongst ecosystem participants, but also internal collaboration amongst the central bank's functions could also help identify additional use cases of the same regtech solution.

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[173] See Exhibit 6: Regulatory Sandboxes and their Role in Regtech. See also Perlman, L, Wechsler, M & Gurung, N (2018) *The State of Regulatory Sandboxes in Developing Countries*, available at www.dfsobservatory.com

[174] See Exhibit 6: Regulatory Sandboxes and their Role in Regtech

[175] 421 (2018) *Regtech is here- Time to turn Regulatory Compliance into a Competitive Advantage*, available at https://bit.ly/2Jb3vjh

[176] IIF (2016) *Regtech in Financial Services: Technology Solutions for Compliance and Reporting,* available at https://goo.gl/A62STL

[177] Enriques, L (2017) *Financial Supervisors and Regtech: Four Roles and Four Challenges*, available at https://goo.gl/akR8by

Regulatory sandboxes are a flexible framework to facilitate beneficial innovation in the financial sector while still managing risks (such as consumer protection and stability of the marketplace) of newer technologies.[178] They are controlled, safeguarded environments (for both regulated and unregulated institutions, including fintech and regtech participants) to live test innovations (which would ordinarily be stifled by regulatory uncertainty or incompatibility) under the regulator's supervision for a limited duration.[179]

As of 3Q 2018, over 50 countries had operational or proposed regulatory sandboxes.[180] They were originally established in developed countries to *inter alia* promote competition, innovation, consumer benefits and financial inclusion and are structured in a variety of ways with regards to eligibility, criteria, costs, timing and exit processes.[181] Regulatory sandboxes generally foster meaningful dialogue between the sandbox participants (who communicate regularly during the testing period) which builds capacity for both regulators and innovators. Complements to regulatory sandboxes, such as innovation hubs, are designed to enhance and increase knowledge sharing and promote a collaboration between FinTech ecosystem participants.

In the regtech context, ecosystem participants are TSPs, and regulators. Specifically, regulatory sandboxes can address regulators' challenges to understand existing and emerging innovations, as well as TSPs' challenges to understand complex regulations and regulatory expectations by creating a platform for open knowledge exchange.[182] Experimentation with sandboxes and the dialogue with sandbox participants, whether the technologies used ultimately fail or succeed, also allows regulators to better understand technologies and the risks associated with them.

Some regulatory requirements may be required to be relaxed to establish a regulatory sandbox (and allow participants to operate where regulatory uncertainty or incompatibility exists) which may also be under the supervisory scope of another regulator.[183] Thus, collaboration between different authorities to initiate regtech-type sandbox initiatives may be necessary and usually manifests in a MoU between authorities.

Exhibit 6: Regulatory Sandboxes and their Role in Regtech

Regulators collaborate with ecosystem participants to further innovation in fintech, and also in regtech, through multiple initiatives such as regulatory sandboxes[184] and fintech labs. The sandbox approach allows new products to be tested in a specific environment without regulatory burdens.[185] Labs are dedicated to supporting fintechs.[186] They could be resource center that keeps track of fintech developments and assists fintech providers in navigating

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[178] FCA (2015) *Regulatory Sandbox,* available at https://bit.ly/2EG5Lez

[179] MAS (2017) *Financial Regulation – The Forward Agenda*, available at https://bit.ly/2kL4RZx; Toronto Center (2017) *Regulatory Sandboxes,* available at https://bit.ly/2Hx0EAg; Electronic Money (2017) *Regulators and Fintech: Influence Is Mutual?,* available at https://bit.ly/2HsUJw8

[180] Perlman, L, Wechsler, M & Gurung, N (2018) *The State of Regulatory Sandboxes in Developing Countries*, available at www.dfsobservatory.com; CGAP (2017) *Regulatory Sandboxes and Financial Inclusion*, available at https://goo.gl/XMAA2m; Buckley, R (2017) *Regtech & Financial Inclusion*, available at https://dfsobservatory.com/event/regtech-financial-inclusion

[181] *ibid.*

[182] Toronto Center (2017) *Regulatory Sandboxes*, available at https://bit.ly/2Hx0EAg

[183] Banking Stakeholders Group (2017) *Regulatory Sandboxes*, available at https://bit.ly/2qtolRZ

[184] See Exhibit 6: Regulatory sandboxes and their Role in Regtech

[185] *ibid.*

[186] CFTC 2018) *LabCFTC,* available at http://www.cftc.gov/LabCFTC/Overview/index.htm; Gach, R & Gotsch, M (2017) *Fintech Goes to Washington: Regulators, Financial Firms Discuss Wave Of Future,* available at https://bit.ly/2xRexEv; Loizos, C (2017) *Startups Say This Fintech 'Lab' Is Giving Them Needed Access To Wall Street And Regulators,* available at https://tcrn.ch/2qqV2jP

regulatory frameworks.[187] These initiatives create spaces for regulators and TSPs to understand the potential and risks of new technologies and the impact of new regulations.

4.2. Inter-Regulator Collaboration

4.2.1. National Collaboration

Many national regulators are implementing regtech solutions in isolation primarily due to the lack of uniformity in regulatory standards, legacy systems and IT capabilities between the national regulators.[188]

Clearly regulators with common concerns and remits – for example on security or KYC – need to collaborate. Facilitation of cooperation and, as needed, standardization should be through at a minimum, a MoU[189.] where predefined roles, responsibilities and expectations outline the degree of collaboration and cooperation and what is expected of each regulator.

For example, in designing regtech solutions for DFS, the telecommunications regulator, central bank, anti-money laundering unit (AMLU), and those with remit over issuance of national IDs need collaboration, lest it lead to an ecosystem breakdown as occurred recently in Uganda.[190].

A regtech solution – which could also be part of a KYC utility[191] - that effortlessly integrates required CIV and associated reporting data is a useful pivot for impacted regulators to embark on a regtech solution journey.

For compliance-related solutions – again an example on KYC-related issues – impacted regulators could liaise with their supervised or impacted entities to undertake a needs and solution analysis, possibly in a collegial set of workshops followed by ongoing workgroups that set the standards for any regtech solutions based on market capabilities and regulator resources.

4.2.2. Cross-Border and Regional Collaboration

A new trend is the establishment of formal agreements between regulators in neighboring countries to facilitate data sharing between them to ensure financial and telecommunication ecosystem is safe and secure.

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[187] Toronto Center (2017) *FinTech, Regtech and SupTech: What They Mean for Financial Supervision*, available at https://goo.gl/R3vWxH

[188] Accenture (2017) *How FinTech is Changing the Regulatory Environment: Compliance Keynote at Next,* available at https://goo.gl/RmV1Ze

[189] A formal agreement between two or more parties that outline the details of the understanding, which includes requirements and responsibilities of each of the involved parties. Summarized from The Law Dictionary (2018) *What is Memorandum of Understanding (MOU)?,* available at https://bit.ly/2Ra5x6d/; Collins (2018) *Memorandum Of Understanding*, available at https://bit.ly/2qvg4NI

[190] Daily Monitor (2017) *UCC Releases Guidelines for Sim Card Switch Off,* available at https://bit.ly/2GX4uSb; africanews (2017) *Authorities in Uganda to Switch Off Two Million Unregistered Sim Cards,* available at https://bit.ly/2CZpv0e

[191] See Section 7.2: Shared Utilities as Regtech

The Monetary Authority of Singapore (MAS) has been collaborating with financial ecosystem participants through platforms such as the Financial Services Information Sharing and Analysis Center (FS-ISAC), which is a forum with 7,000 financial institutions as members. [192]

They are establishing the Asia Pacific Regional Intelligence and Analysis Center (APAC) which promote sharing and analysis of cybersecurity information within the financial sector.[193]

The sharing of cyber intelligence in real-time is important for regulators as they may be vulnerable to global cyber threats but proper steps must also be taken address issues concerning the security and privacy of customers.[194]

Exhibit 7: MAS and FS-ISAC Collaborate for Cybersecurity Information Sharing

Kenya, Rwanda, Uganda and South Sudan for example are developing a common cross-border mobile Subscriber Identity Module (SIM) card registration framework to reduce rising crimes using mobile devices.[195] This regtech solution could impact DFS as unregistered SIM cards will be deactivated and providers will be able to associate accounts and transactions to specific individuals.[196]

The initiative is part of the One Network Area (ONA) agreement between the East African Community (EAC)[197][198] which was originally aimed at reducing roaming charges by harmonizing voice call charges, but which has now been expanded to include data and DFS services.[199] The aim is to harmonize cross-border DFS transfer regulations as well as uniform rates.[200]

Along with a common SIM card registration framework, four East African countries have signed an agreement to interconnect their national ID systems as means to ensure that people are not able to create fake nationalities and identities when they move from one country to country.[201]

National ID cards will be linked to SIM cards of mobile users, and data sharing between the regulators facilitated by regtech will allow users to be traced across borders.[202]

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[192] MAS (2017) *Singapore FinTech Journey 2.0*, available at https://www.bis.org/review/r171115a.pdf

[193] *ibid.*

[194] Caldwell, G (2016) *Why You Should Be Concerned About the Cybersecurity Information Sharing Act*, available at https://tcrn.ch/2OImlEs

[195] Daily Nation (2013) *East African States to Share Sim Card, National Id Data,* available at https://bit.ly/2EIZleU

[196] *ibid.*

[197] Burundi, Kenya, Rwanda, Tanzania, Uganda, and to some extent South Sudan. Cited from Kelly, T & Kemei, C (2016) *One Network Area in East Africa,* available at https://bit.ly/2IMoV4U

[198] Daily Nation (2015) *East Africa Countries Move Closer to Common Sim Card Registration,* available at https://bit.ly/2IPDYen

[199] ITU (2016) *A Case Study of ONA: East Africa One Network Area Roaming Initiative,* available at https://bit.ly/2rhMn3B

[200] Ligami, C (2015) *Mobile Money Now Crosses Borders in Four East Africa Countries,* available at https://bit.ly/2GVW3L1

[201] Daily Nation (2013) *East African States to Share Sim Card, National Id Data,* available at https://bit.ly/2EIZleU

[202] Daily Nation (2015) *East Africa Countries Move Closer to Common Sim Card Registration,* available at https://bit.ly/2IPDYen

This initiative could further improve the provision of DFS by helping to identify users and to address fraudulent activities and money laundering (ML).[203]

Regulators[204] are also sharing information on financial service innovations in their markets.[205] Market participants and regulators are collaborating both domestically and internationally to share knowledge on trends, issues, and strategies in the financial industry.[206]

The UK FCA has been working with regulators and regtech providers around the world to share their work and learn from others.[207] They signed a MoU with the United States Commodity Futures Trading Commission (CFTC) to share information related to regtech.[208]

They have set up agreements with the Australia Securities and Investments Commission (ASIC) and MAS separately to make it easier for involved parties in pursuing fintech opportunities in these countries.[209] Furthermore, FCA, ASIC and MAS have also proposed regulatory sandboxes[210] and accelerator programs in their jurisdictions to support innovation in fintech[211]

Such collaboration can not only be cost effective but can also promote harmonization of regulatory responses and approaches to foster regtech innovation.[212]

Exhibit 8: Collaborative Efforts of the UK Financial Conduct Authority (FCA)

4.2.3. Supra-national Standardization

Standardization is key in supra-national collaboration. The Bank of International Settlements (BIS) for example is leading these efforts, encouraging supervisors to share data.[213] This impetus towards standardization is handicapped, however, by disparate legal regimes and the lack of standardization in 'data plumbing' used by various national

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[203] Money laundering refers to the conversion or transfer of property or any association, knowing it is derived from criminal activity, for the purpose of hiding its origins, nature, location, disposition, movement, ownership. Summarized from European Investment Bank Group (2018) *Anti-Money Laundering and Combating Financing of Terrorism Framework,* available at https://bit.ly/2HX4QMH; International Monetary Fund (2018) *Anti-Money Laundering/ Combating the Financing of Terrorism (AML/CFT)*, available at https://bit.ly/1M7MEsz

[204] Including those in Abu Dhabi, Australia, Canada, China, France Hong Kong, India, Kenya, Singapore, South Korea, Switzerland, UK. Deloitte (2017) *Connecting Global FinTech: Interim Hub Review 2017*, available at https://goo.gl/LLqUGM

[205] *ibid.*

[206] Trulioo (2017) *Global Regulators Collaborate as Fintech Goes Cross-Border*, *a*vailable at https://bit.ly/2KxgFYc

[207] CNBC (2017) *UK Regulator Looking to Use Ai Machine Learning to Enforce Financial Compliance,* available at https://goo.gl/8L4RdU

[208] CFTC, FCA (2018) *Cooperation and the Exchange of Information on Financial Technology Innovation,* available at https://bit.ly/2IK6U7a

[209] Trulioo (2017) *Global Regulators Collaborate as Fintech Goes Cross-Border*, available at https://bit.ly/2KxgFYc

[210] See Exhibit 6: Regulatory sandboxes and their Role in Regtech

[211] Accenture (2017) *How FinTech is Changing the Regulatory Environment: Compliance Keynote at Next,* available at https://goo.gl/RmV1Ze

[212] Medcraft, G (2016). *Cross-Border Innovation: Enabling Fintech and Regtech Innovations Across Borders*, available at https://bit.ly/2jswOlu; Ronde, E (2017) *Fintech and Regtech Agreement Between Hong Kong and The UK,* available at https://bit.ly/2EF4Yuv

[213] Caruana, J (2012) *Interconnectedness and The Importance Of International Data-Sharing,* available at https://www.bis.org/speeches/sp120730.htm

(and regional) regulators. Standardization could open up increased ability to analyze data, using AI and machine learning mechanisms that are available, but not currently 'packaged' as supervisory regtech solutions.

B. Business Case

4.3. Business Case for Solution Development

The potential for technologies to address central banks' needs and the central banks' inability to develop technologies in-house provides opportunities for TSP to innovate and fill the market gap. The large scale and customer block of central banks can be inviting for TSPs to engage in provision of regtech. TSPs are however reluctant to do so because they do not see a sufficiently large and sustainable market opportunity since central banks in different jurisdictions usually have different requirements that require different regtech solutions. TSPs – especially startups – may hence find that they are unable to scale their solutions to different central banks, or to slightly tweak their solutions to fit the needs of multiple central banks.

To sustain their existence, TSP seek to scale their offerings in so far as they can develop and provide regtech services not necessarily for just one department in one central bank, but to many regulators within a country or to many central banks in a region. Their innovation could be a part of a global suptech or regtech standardization efforts.

Through regulators standardizing on specific methodologies and APIs, the universe of available solutions will immediately emerge from larger pools of TSPs to design appropriate standardized regtech solutions.

C. Procurement Processes

4.4. Procurement: Internal Procurement Processes

Procurement processes for regtech may favor large and established TSP mainly because of their experiences and their ability to harness economies of scale.[214] Even though public procurement processes may avoid biases and favoritism relative to private procurement processes, the existence of large tech players and competitive environment could foreclose on new innovative startups or even discourage startups to enter the space.[215] Recognizing the importance of contracts to startups and their contribution to innovation in the field, smaller contract sizes and quotas could help build a competitive marketplace.[216]

5. Emerging Use Cases for Regtech

5.1. Overview

The adoption and exploration of regtech use has progressed to varying degrees based on the objectives and their underlying technological solutions. Regtech is being used for automating reporting process,[217] collection of granular data,[218] access to new flows of information,[219] predictive and algorithmic supervision,[220] proper implementation of rules,[221] and improvement and integration of internal processes.[222] The discussion on different issues regtech is addressing around the world emphasizes its vast potential for central banks in developing countries.

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[214] Smedley, T (2013) *Public Procurement: Is Open Competition Bad For Development?,* available at https://bit.ly/2FFu5h7

[215] European Bank for Reconstruction and Development (2017) *Public Procurement Is Open Competition Good For Small And Medium-Sized Enterprises?,* available at https://bit.ly/2FFrLH4

[216] G20 (2016) *Preferential Public Procurement*, available at https://bit.ly/2hBj8a0

[217] See Section 5.2: Automated Report Submission and Data Quality Management

[218] See Section 5.3: Collection of Granular Data

[219] See Section 5.4: Access New Flows of Information

[220] See Section 5.5: Predictive and Algorithmic Supervision

[221] See Section 5.6: Machine Readable Regulations

[222] See Section 5.7: Improvement and Integration of Internal Processes

5.2. Automated Report Submission and Data Quality Management

There has been a shift to automated reporting and data quality management using integrated rules and validations, especially in developed countries.[223] This has been widely adopted by 25 regulators, including the Bank of England Prudential Regulation Authority, Bank of Canada, Central Bank of Oman, Central Bank of the Bahamas, Bank of Jamaica, and the Namibian Financial Institutions Supervisory Authority.[224]

Regtech solutions with such objectives can provide multiple features such as master data management system; review and approval of regulatory transactions and licenses; supervisory data collection with quality controls; risk profiling of market participants and sharing data with downstream systems and other regulators.[225] The automated collection, validation, analysis and sharing of the data streamlines reporting requirements, fostering cost and time savings for both regulators and market participants. Despite regtech benefits, in developing countries that face multiple unique challenges, manual submission of data using templates, spreadsheets, emails and paper is still prevalent.[226]

5.3. Collection of Granular Data

Some regulators require market participants to provide aggregated data using their reporting templates where many data fields in multiple templates require the same underlying data.[227] Aggregated data and template-based reporting has limitations which can be addressed by the collection of granular data, allowing for greater flexibility in analysis, multiple-use of data, and consistency in reporting and source-validation.[228]

Granular data can be obtained through what are termed 'push approaches' or a 'pull approaches.' The 'push approach' requires market participants to automatically upload standardized sets of granular data on to a central database using an API.[229] In the 'pull approach,' raw data is extracted directly from market participant's IT systems by the supervisor using a 'probe.'[230] Since data is not aggregated beforehand, it reduces the burden on market participants - but can increase the corresponding burden on regulators. It may be beneficial for regulators to incorporate additional features to the pull and push approach-based technology that automates raw data processing.[231]

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[223] Toronto Center (2017) *FinTech, Regtech and SupTech: What They Mean for Financial Supervision*, available at https://goo.gl/R3vWxH

[224] For more information: Vizor (2017) *About*, available at https://vizorsoftware.com/about/; MIMICS (2018) *Central Banking,* available at https://www.mimics.com/central-banking

[225] Vizor (2017) *Vizor Licensing and Regulatory Transactions*, available at https://bit.ly/2ytCDqO; Vizor (2017) *Vizor Regulatory Returns*, available at https://bit.ly/2JchmWP

[226] Dias, D & Staschen, S (2017) *Regtech and Digital Finance Supervision: A Leap into the Future*, available at https://bit.ly/2GThDQe

[227] See Annex C, Annex D, Annex E, Annex G

[228] BearingPoint (2016) *Reforming Regulatory Reporting: From Templates to Cubes*, available at https://bit.ly/2GVttp9

[229] Dias, D & Staschen, S (2017) *Data Collection by Supervisors of Digital Financial Services*, available at https://goo.gl/YHB4w3

[230] *ibid.*

[231] Regulatory probes are in use in DFS systems in Tanzania and Rwanda, ostensibly for AML and tax supervision purposes. Use of a probe by the telecommunications regulator in Kenya faced court challenge by the MNOs there based on privacy concerns,

The Oesterreichische National Bank (OeNB), the central bank of Austria, and the country's banks uses a data input approach to regulatory reporting. The Austrian banks have founded a joint venture called the Austrian Reporting Services (AuRep) which acts as the central interface between banks and OeNB. It aims to harmonize data collection and integrate IT systems between OeNB and the banks.

The model requires banks to provide granular data in a standard format in a series of basic data cubes. AuRep acts as an intermediary that transforms the data cubes to smart cubes according to the market participant's business type and formatted as per OeNB's regulatory requirements. If there is a change in the required data, only a single change in AuRep may be necessary to implement data collection change across entities data. Moreover, additional data requests can be processed by AuRep when smart cubes are formed from basic data cubes.

While the approach seems to be focused on reducing the cost of regulatory reporting across Austria, the involvement and acceptance of this reporting process by OeNB also reduces data management and monitoring requirements, time in implementation of regulatory requirements, and compliance demands for FIs.

Exhibit 9: Austria- OeNB Collects Granular Data Using AuRep[232]

5.4. Access To New Flows of Information

Manual collection and handling of data features lags in regulatory responses and limitations for data modelling. However, new technologies are opening up access to new flows of information,[233] providing data from previously untapped sources, driving access to real-time data for supervision and obtaining insights from unstructured data.[234] Increase in volume, velocity and variety of data can fuel better supervision if regulators have the capacity to analyze them.[235]

A technology gaining increasing attention from regulators because of its secure and advanced information sharing is DLT using blockchain protocols.[236] In a DLT, data is recorded and stored, transactions are proposed and validated, and records are updated in a synchronized manner across the distributed network of computers.[237] Blockchain is a specific type of DLT that uses cryptographic and algorithmic methods to record transactions between computers on a network.[238] Transactions are grouped into 'blocks.'[239] As new blocks form, they are confirmed by the network and connected to the block before it, thus creating a verified and tamper-evident chain of data blocks..[240]

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[232] Combined from BearingPoint (2018) *Reforming Regulatory Reporting: Are We Headed Towards Real-Time?,* available at https://goo.gl/58CYyy; Bearing Point (2018) *Regulatory Utilities*, available at https://goo.gl/wxY8PL

[233] See Exhibit 14: Summary of Regtech Use Cases

[234] FSB (2017) *Artificial Intelligence And Machine Learning In Financial Services*, available at https://bit.ly/2lK4Be2

[235] See Section 6.4.2: Capacity of Regulators

[236] For an overview of blockchain and DLTs, see Perlman, L (2017) *Distributed Ledger Technologies and Financial Inclusion*, available at https://bit.ly/2nyxpBG; and Ramachandran, V & Woodsome, J (2018) *Fixing AML: Can New Technology Help Address the De-risking Dilemma?*, available at https://bit.ly/2IKMECI

[237] BIS (2017) *What is Distributed Ledger Technology?,* available at https://www.bis.org/publ/qtrpdf/r_qt1709y.htm; World Bank Group (2017) *Distributed Ledger Technology (DLT) and Blockchain,* available at https://bit.ly/2Go5Zct

[238] IBM (2018) *Blockchain 101,* available at https://ibm.co/2HjoNwC; Iansiti, M & Lakhani, K (2017) *The Truth About Blockchain,* available at https://hbr.org/2017/01/the-truth-about-blockchain; World Bank Group (2017) *Distributed Ledger Technology (DLT) and Blockchain,* available at https://bit.ly/2Go5Zct

[239] Martindale, J (2018) *What is a Blockchain? Here's Everything You Need to Know,* available at https://bit.ly/2DoWE1J; IBM (2018) *ibid.*

[240] *ibid.*

The US Consumer Financial Protection Bureau established a platform in 2011 that accepts complaints from consumers on a range of different topics. Over the years, it has focused on developing the database so that it can be viewed and searched easily and passing on anonymized complaints to providers so that it can be addressed or responded. The regulator analyzes data to identify issues in the marketplace and publish reports on the complaints.

The main aim of this regtech solution has been to identify inappropriate practices in the industry and take measures to encourage respective entities to correct them. It also empowers consumers and ensures a level of consumer protection.

Exhibit 10: US Consumer Financial Protection Bureau Opens Access to New Information[241]

A 'permissioned' blockchain's inherently shared design provides access to new flows of information.[242] If regulators can become part of blockchain, they can view all transactions, and monitor compliance in real-time, even potentially being able to enforce regulations.[243] Regulators and market participants will also not have to store replicated records. Moreover, applications can be built on top of blockchain technology such as smart contracts[244] which self-execute, requiring less monitoring once set up and easing supervision burden.

Even though blockchain technology is considered to be secure, some iterations have raised security concerns.[245] For example, public blockchains allow any computer connected to the internet to join the network.[246] And transactions are verified through consensus which is more problematic when the network size is small because if a user gets control of 51% of the participants in the network, they can have complete control of the outcomes.[247] Private blockchains on the other hand allows an operator to determine who can join the network, who can submit transactions and who can verify them.[248] This may introduce insider threats. It is thus important for users, market participants and regulators to understand the specifics of the technology and its risks.

Despite the security issues, financial infrastructure based on blockchain technology can potentially reduce cost of compliance, increase ease in adapting to changing regulatory requirements and promote more efficient markets.[249] Specifically, the range of emerging DLTs – such as Iota, Hashgraph, and Ripple - can be used for various financial

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[241] Consumer Financial Protection Bureau (2018) *Consumer Complaint Database*, available at https://bit.ly/2nGDsc7

[242] Akmeemana, C, Bales, D & Lubin, J (2017*) Using Blockchain to Solve Regulatory and Compliance Requirements,* available at https://bit.ly/2IKbfYf; Iansiti, M & Lakhani, K (2017) *The Truth About Blockchain,* available at https://hbr.org/2017/01/the-truth-about-blockchain

[243] Toronto Center (2017) *FinTech, Regtech and SupTech: What They Mean for Financial Supervision*, available at https://goo.gl/R3vWxH

[244] Self-executing programs that runs automatically on the distributed ledger when pre-defined requirements are met. CFI (2017) *What Happens If The Blockchain Breaks?,* available at https://bit.ly/2nB83mD

[245] Berke, A (2017) *how safe are blockchains? It depends,* available at https://bit.ly/2naCjoO

[246] The Development Bank of Singapore Limited (2017) *Understanding Blockchain Technology and What it Means for Your Business,* available at https://go.dbs.com/2GRREbX

[247] Choi, S, Ko, D & Yli-Huumo, J (2016) *Where Is Current Research on Blockchain Technology? – A Systematic Review,* available at http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0163477

[248] Miles, C (2017) *Blockchain security: What keeps your transaction data safe?,* available at https://ibm.co/2Gpn0GA

[249] Stark, J (2017) *Applications of Distributed Ledger Technology to Regulatory & Compliance Processes*, available at https://bit.ly/2NVGyl7

operations such as settling interbank payments, verifying trade finance invoices, executing performance of contracts and keeping audit trails.[250]

Many regulators are exploring DLT use by conducting theoretical research or through practical testing,[251] with more than 90 central banks engaged in DLT initiatives or discussions at the end of 2017.[252] Hitachi Data Systems has been using MAS's sandbox to test the use of blockchain systems to issue and settle checks.[253] MAS has also partnered with the state government of the Indian state of Andhra Pradesh to launch pilots for public-sector application of blockchain;[254] while Estonia is already using blockchain for identification and tax payment purposes.[255]

These DLT-based initiatives are in the early stages of development, but have shown promise in improving financial infrastructure by increasing speed, security and transparency.[256]

The South African Reserve Bank (SARB) established a fintech task force in 2018 to monitor and promote fintech innovation to assist them in developing appropriate policy frameworks for FinTech regulation. The taskforce will review SARB's position on crypto-currencies, especially regulatory issues concerning cyber-security, taxation, consumer protection and AML, and will scope out a regulatory sandbox and innovation accelerator. The taskforce will also launch 'Project Khokha' in partnership with US-based DLT technology provider, ConsenSys to assess the risks and benefits of DLT use. They will develop a proof of concept for interbank clearing and settlement using Quorum, a private Ethereum platform developed by JPMorgan.

Exhibit 11: South Africa- New Fintech Unit of SARB[257]

5.5. Predictive and Algorithmic Supervision

The emphasis on data and digital transformation of financial systems has increased regulator's access to large volumes of data on a regular basis.[258] Regulators have to organize, validate and analyze these large data sets. Central

[250] MAS (2016) *Singapore's FinTech Journey – Where We Are, What Is Next,* available at https://bit.ly/2fHjkiE

[251] European Central Bank (2018) *Distributed Ledger Technology: Hype Or History In The Making?,* available at https://bit.ly/2IO6ehd; R3 (2018) *Blockchain And Central Banks- What Have We Learnt?*, available at https://bit.ly/2JGTslM; ccn (2018) *South Africa's Central Bank Launches Ethereum-Based Blockchain PoC*, available at https://bit.ly/2NXzoww; Finextra (2017) *Ripple Boss Predicts Central Bank Adoption Of Blockchain,* available at https://bit.ly/2hFa8Bf; Althauser, J (2017) *Colombia Central Bank to Test Distributed Ledger Technology Corda,* available at https://bit.ly/2iJ3pGg

[252] Baruri, P (2016) *Blockchain Powered Financial Inclusion,* available at https://bit.ly/2JG6mAK

[253] FinTechnews Singapore (2017) *Will Singapore become a Regtech leader? Regulatory Reporting 2.0,* available at https://goo.gl/cvQEbV

[254] Higgins, S (2017) *50 Startups: Central Bank Director Touts Singapore as Blockchain Hub,* available at https://bit.ly/2JbDnF6

[255] Robinson, M (2016) *The Regtech Marketplace: In Depth Analysis*, available at https://bit.ly/2be4wtH

[256] Baruri, P (2016) *Blockchain Powered Financial Inclusion,* available at https://bit.ly/2JG6mAK

[257] Finextra (2018) *Cryptocurrencies, Sandboxes and Blockchain Experimentation Top Sarb Fintech Agenda,* available at https://bit.ly/2swGsLd; Nation, J (2018) *South African Reserve Bank's FinTech Programme to Pilot Quorum for Interbank Transfers,* available at https://bit.ly/2JGpdvF

[258] The application of digital technology in the financial industry to improve existing capabilities and deliver new ones. Summarized from Foldesy, J, Roos, A & Tucket, J (2017) *How Digital CFOs are Transforming Finance,* available at https://on.bcg.com/2wasbWu; Deloitte (2016) *Crunch Time: Finance In A Digital World,* available at https://bit.ly/2k14V6t; PwC (2017) *Top Financial Services Issues Of 2018,* available at https://pwc.to/2JOK7HY

banks use of big data analytics, AI and machine learning can allow regulators to make real-time predictions using the available data.[259]

With these newer technologies, regulators can also monitor transaction activities in large data sets, compare them to other lists of data using data mining[260] and can identify risky transactions more accurately and efficiently[261] using pattern recognition[262] and natural language processing.[263]

Increases in accuracy of system may reduce resources dedicated to monitoring,[264] although regulators need to be cautious regarding the emergence of algorithmic biases.[265] That is, despite the technology driven data analysis trends, there is still need for regulators to interpret the results and determine the policy implications.

The MAS has launched a data analytics group which develops and promotes data analytics for financial supervision. They work to organize the available data, deploy appropriate tools for analysis, put in place enabling infrastructure and build skill sets of supervisors. They are developing algorithms to scan suspicious transaction reports and trading accounts to identify activities that require further attention.

Exhibit 12: Singapore- MAS Uses Data Science and Machine Learning[266]

5.6. Machine Readable Regulations

Market participants face challenges in sourcing, tracking and interpreting regulatory texts and identifying and implementing regulations that apply to them.[267] Currently, when undertaking regulatory reporting, market participants manually interpret rules and then manually input them into their systems, which may then be used by their system to produce reports for submission to the regulator.[268] Market participants require time to identify, interpret and then implement applicable regulations and there may be discrepancies in interpretation.

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[259] Alvarez, C (2017) *Artificial Intelligence, The Next Frontier for Banking Regulation*, available at https://www.bbva.com/en/artificial-intelligence-next-frontier-banking-regulation/

[260] Computing process of finding patterns and trends in large data sets. We can use data mining to look for patterns in historical data, estimate unknown outcomes and transform unstructured data for better predictions. Summarized from SAS (2018) *Data Mining,* available at https://bit.ly/2INhBL0; Oracle (2018) *What is Data Mining?*, available at https://bit.ly/2GSwhmN

[261] Robinson, M (2016) *The Regtech Marketplace: In Depth Analysis*, available at https://bit.ly/2be4wtH

[262] Recognition of relationships and regularities in raw data. Zanibbi, R (2018) *Pattern Recognition: An Overview,* available at https://bit.ly/2yVtmXW

[263] Ability of machines to analyze, understand and generate human language. SAS (2018) *Natural Language Processing,* available at https://www.sas.com/en_us/insights/analytics/what-is-natural-language-processing-nlp.html

[264] Bornfreund, M, Petrasic, K & Saul, B (2017) *The Emergence of AI Regtech Solutions for AML and Sanctions Compliance,* available at https://bit.ly/2Hm8Q8S

[265] Bornfreund, M, Greig, J, Petrasic, K, et al. (2017) *Algorithms and Bias: What Lenders Need to Know,* available at https://bit.ly/2S9yaBB

[266] Combined from MAS (2017) *Data Science and Machine Learning in Practice*, available at https://goo.gl/wmZWX4; MAS (2017) *"Financial Regulation- The Forward Agenda",* available at https://bit.ly/2kL4RZx

[267] JWG & Regtech Rising (2017) *The Regtech Revolution and the Path Towards Robo-Rules*. available at https://bit.ly/2xso8QT

[268] FCA (2018) *Call for Input: Using Technology to Achieve Smarter Regulatory Reporting*, available at https://bit.ly/2INSGSQ

The FCA conducted a two week TechSprint in 2017 to explore machine readable reporting regulations as means to reduce reliance of reporting rules on human interpretation. A proof of concept was developed which was successful in portraying regulatory rules into machine readable language. Machines could then assess the rules, determine the data required from market participants, and extract relevant data from the market participant's system to formulate a report for submission. If any changes were made to the regulatory rules, the machine would automatically change the requirements and reporting data.

In order to develop this successful proof of concept, participants in the TechSprint created a directory of regulatory reporting rules, converted it into the Semantics of Business Vocabulary and Business Rules format to standardize legal and regulatory meanings, converted the rules into machine executable format (RDF file), mapped the rules into the market participant's database to determine specific data requirements for the market participant, and tested the effect of rule change in real time.

Exhibit 13: UK FCA and Machine Readable Regulations[269]

Market participants can certainly benefit from regulatory text in a language that machines can understand – that is, machine readable regulations – which can be directly introduced into market participants' IT system without human intervention to automatically implement embedded rules and close the gap between intention and interpretation.[270] This could ensure the proper and quicker implementation of regulatory requirements, reduce cost and inefficiency of outside consultations for market participants and increase accuracy of data submissions.[271]

5.7. Improvement and Integration of Central Bank Internal Processes

Central banks are tasked with a number of competencies, including oversight of the banking system, providing core financial infrastructure, maintaining monetary and financial stability and taking catalytic roles in innovation.[272] In most cases though, the various departments of the central bank work in isolation, [273] potentially with varying reporting requirements and formats. Internally-focused regtech may provide a digital architecture that integrates the different functions of the central bank to replace the disparate parts with a fully automated, standardized system that allows real-time monitoring, customized analytics and report generation for submission to the government.[274]

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[269] FCA (2017*) Model Driven Machine Executable Regulatory Reporting,* available at https://bit.ly/2hG1bEb; FCA (2018) *Call For Input: Using Technology To Achieve Smarter Regulatory Reporting*, available at https://bit.ly/2INSGSQ

[270] Reichman, C (2016) *Fca Eyes Robo-Regulation to Reduce Cost for Firms,* available at https://bit.ly/2Hh3qw8.

[271] Robson, N (2017) *FCA Publishes Regtech Website*, available at https://bit.ly/2vaL4Ig

[272] BIS (2018) *Roles and Objectives of Modern Central Banks,* available at https://www.bis.org/publ/othp04_2.pdf; Nier, E (2009) *Financial Stability Frameworks and the Role of Central Banks: Lessons From the Crisis,* available at https://www.imf.org/external/pubs/ft/wp/2009/wp0970.pdf; Perlman, L (2018) *The Role of Central Banks in DFS*, available at www.dfsobservatory.com; Amadeo, K (2018) *Central Banks' Function and Role,* available at https://bit.ly/2dujdG9. In Jordan, the Central Bank of Jordan played a catalytic role in innovation by introducing JoMoPay (an abbreviation of Jordan Mobile Payments), a national switching infrastructure that enables interoperability of mobile payment services. It allows the central bank to oversee all transactions and also promotes uptake and use of mobile money by making customer experiences seamless and allowing cross-provider transactions. Summarized from ProgressSoft (2014) *The Central Bank of Jordan Launches ProgressSoft's Mobile Payment Switching & Clearing Platform,* available at https://bit.ly/2rjJAXL; CGAP (2017) *Paving the Way for Digital Financial Services in Jordan,* available at https://bit.ly/2rnr7sK

[273] Openlink (2018) *Central Banking,* available at https://bit.ly/2wauusz; Central Banking (2017) *Technology Provider of The Year: Calypso Technology,* available at https://bit.ly/2Hwj7gy

[274] In conversation with Bank of Russia, it was found that they are exploring a common internal regtech for harmonizing internal functions such as reporting tiemes and formats. See also Olympic Banking System (2018) *Central Bank*, available at https://bit.ly/2JOwpVy; Central Banking (2015) *Technology Provider of the Year: Polaris,* available at https://bit.ly/2GUbyU1

The digital architecture could interface other software, networks, and systems like SWIFT,[275] automated clearing houses (ACH)[276], and real time gross settlement (RTGS)[277] system to give real-time information to central banks.[278]

Regtech can, however, also address a specific internal issue and improve internal central bank process, for example to: automate central bank processes; optimize statistical processes; automatically manage access rights of employees based on their roles; assist with employee onboarding; and even manage human resource.[279] Automation may reduce manual work and increase time and resources for analytical work within the central bank.

As mentioned above, externally-focused regtech solutions can automate data collection,[280] while internally-focused regtech solutions can automate analysis and publishing of the data. Such analytical tasks may require collaboration amongst different technical and functional departments within the central bank. A common and automated regtech solution can reduce repetition and conflicts between workflows, interfaces, applications, and databases.[281]

Existing central bank processes are, however not enough for them to properly monitor the changing financial sector. They could learn from commercial banks' innovative adoption of open banking using APIs to develop and share new cost-effective operational solutions that address their growing need for new functionality which comply with the changing regulatory requirements.[282] APIs could similarly foster collaboration amongst central banks and TSPs to allow seamless integration of innovative new tools into the central bank's legacy system.

There are, however, scalability and flexibility limitations in legacy banking systems.[283] Blockchain-based technologies are being explored to upgrade existing legacy core banking systems in banks, including processing of deposits, loans, withdrawals, and credit as well as data sharing amongst bank branches.[284] Vault, for example, is an alternative to legacy core banking system based on a centralized, permissioned cryptographic ledger that processes transactions.[285] It provides a wide array of retail-banking products using smart contracts, data analysis, real-time databases, and customer relationship management.[286]

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[275] The Society for Worldwide Interbank Financial Telecommunication. It provides a network that enables financial institutions worldwide to send and receive information about financial transactions in a secure, standardized and reliable environment.

[276] System that processes payments electronically instead of paper checks for routine payments. Depository institutions send each other electronic credit and debit transfers. Summarized from FED (2018) *Automated Clearinghouse Services,* available at https://www.federalreserve.gov/paymentsystems/fedach_about.htm; Federal Reserve Bank of New York (2018) *Automated Clearing Houses,* available at https://nyfed.org/2JQAd8L

[277] Settlement of interbank funds transfer on a continuous, transaction-by-transaction basis without bundling or netting with other transaction through the processing day, BIS (1997) *Real-time Gross Settlement Systems,* available at https://www.bis.org/cpmi/publ/d22.pdf

[278] MIMICS (2018) *Central Banking,* available at https://www.mimics.com/central-banking, Central Banking (2015) *Technology Provider of the Year: Polaris,* available at https://bit.ly/2GUbyU1; Openlink (2018) *Central Banking,* available at https://bit.ly/2wauusz

[279] Roland Berger (2017) *Central Banking It of the Future,* available at https://bit.ly/2KBcniG

[280] See Section 5.2: Automated Data Submission and Data Quality Management

[281] Roland Berger (2017) *Central Banking It of the Future,* available at https://bit.ly/2KBcniG

[282] Marous, J (2017) *The Future of Banking Depends On Open Banking APIs,* available at https://bit.ly/2sXMV0g

[283] Finextra (2018) *How Open Banking Will Blow Core Systems Out of the Water,* available at https://bit.ly/2GKaKfz

[284] Thought Machine (2018) *Vault,* available at https://thoughtmachine.net/vault; Das, S (2016) *Successful Banking Blockchain Test Shows Core Banking Possibilities,* available at https://bit.ly/2juxgzr; Finextra (2017) *Blockchain-Based Banking Startup Babb Signs Infrastructure and Licensing Deal with Contis,* available at https://bit.ly/2HO0ELI

[285] Thought Machine (2018) *ibid.*

[286] *ibid.*

Use of DLT by central banks could also provide similar functionality, but the focus of central banks currently appears to be mainly on DLT use for payments and settlements.[287]

Country	Regulator	Challenge	Regtech Solution	Year	Donor/Consultant
Austria	OeNB	Lack of harmonization in data collection	AuRep: Data input approach to collect granular data from banks' IT system		
Bahamas	Central Bank of The Bahamas		ORIMS by Vizor: Automation of data collection, validation, storage, reporting and analysis	2015	
Bermuda	Bermuda Monetary Authority	AML analysis across all supervisory entities; Blockchain analysis	The BMA is using CipherTrace to track transactions across the blockchain. It's internally testing use of AI and machine learning to enhance AML/ATF and prudential analytics.[288]	2018	
Canada	Bank of Canada	Collection of multiple forms from market participants	Vizor Regulatory Returns Reporting: Ensure submission of quality data by FIs to centralized reporting portal	2014	
Ghana	Bank of Ghana		Program suspended		Regtech for Regulators
India	RBI	Reliance on lag-time and manual data collection.	Automated data retrieval from FI's systems along with predictive analysis.	~2016	Yes
Jamaica	Bank of Jamaica		JamFIRMS: Improves data collection and analysis processes from internal and external sources.	2017	
Mexico	CNBV	Manual reporting of AML data is time consuming to monitor	Infrastructure: Access-controlled data storage platform. Stores data submitted by FIs and automatically validates, analyzes and reports it.	~2018	Regtech for Regulators, Gestell
Nepal	NRB	High financial exclusion in the country	E-mapping platform: Uses GIS system to map all financial points in Nepal.	2017	UNCDF, MM4P
Nigeria	CBN	Large amounts of identity theft and fraud.	BVN: Unique identification number for users to execute banking transactions and a watch-list of fraudulent user's BVN.	2014	BFA
Philippines	BSP	Submission of reports using emails	APIs: BSP can obtain raw data directly from the FIs system and automatically validate, analyze and report it.	~2018	Regtech for Regulators, Compliant Risk Technology

[287] O'Leary, R (2017) *Brazil's Central Bank Considers Blockchain Settlement Prototype,* available at https://bit.ly/2xLPu5o; Coleman, L (2018) *Central Banks: Blockchain Will Overhaul Securities Settlements,* available at https://bit.ly/2ECvLN3; Das, S (2018) *South Africa's Central Bank Lauches Ethereum-Based Blockchain PoC,* available at https://bit.ly/2NXzoww; Mills, D, Wang, K, Malone, B, et al. (2016) *Distributed Ledger Technology In Payment, Clearing And Settlement,* available at https://bit.ly/2hbpPy7

[288] BMA (2018) *BMA Releases Licensing Requirements For Digital Asset Businesses*, available at https://bit.ly/2yxyDo7.

Russia	BOR	Daily collection of bank transaction data. Harmonizing internal bank department data.	In development	2018	
Rwanda	BNR	Need to monitor diverse range of F SP	EDW system with Sunoida Solutions: Allows BNR to pull data from FSPs' systems and monitor in real time. RURA also has a similar system to monitor mobile money activity.	2017	
UK	FCA	Frequent changes in rules increased burden on FIs	Machine readable regulations: Changes will be automatically implemented in the FIs systems.	In progres s	
USA	Consumer Financial Protection Bureau	Limited interactions between regulators and consumers	Database of complaints: Can be populated, viewed and searched by market participants.	2011	

Exhibit 14: Summary of Regtech Activities[289]

6. Challenges with Regtech Development in Developing Countries

6.1. Overview

While there are opportunities for regtech in developing countries,[290] developing and developed countries differ in their industrialization, income, education, and inequality levels, differences which invariably lead to disparate abilities to implement new technologies by regulators.[291] The high cost of regtech,[292] involvement of multiple participants in the development process,[293] poor cyber-security and privacy infrastructure,[294] limited capacity of supervisors and market participants,[295] lack of regtech procurement expertise,[296] and integration of legacy technologies and processes[297] in developing countries can pose challenges to regtech adoption..

6.2. Cost

Development and implementation of regtech by regulators and industry may impose high set-up costs, time and effort.[298] For example, companies involved in the tendering process for a collateral management system at the Central Bank of Sweden, Sveriges Riksbank, submitted tenders ranging from 2 million to 8 million euros.[299] Upfront capex costs to implement regtech solutions can limit investments by central banks in developing countries who do not have the financial resources compared to their developed world peers.

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[289] For abbreviations and more information, see Annex B

[290] See Exhibit 14: Summary of Regtech Use Cases, Section 2: The Case of Regtech/ Evolution of Regtech

[291] Nielsen, L (2011) *Classification of Countries Based on their Level of Development*, available at https://bit.ly/2JEg4n7

[292] See Section 6.2: Cost

[293] See Section 6.6: Sustainability

[294] See Section 6.7: Security

[295] See Section 6.4: Capacity

[296] See Section 6.5: Procurement

[297] See Section 6.3: Context

[298] Financier Worldwide (2017) *The Future Of Regtech: A Skyrocketing Industry?*, available at https://bit.ly/2qrFAnI

[299] Central Banking (2015) *Technology Provider of the Year: Polaris,* available at https://bit.ly/2GUbyU1

The development process, whether in-house or through a TSP, is usually a lengthy one, and will include fundamental requirements such as identifying internal and external needs; assessing the process of development; undertaking procurement of a regtech solution; understanding the regulatory environment, developing and testing a suitable prototype, scaling solutions, strategizing long-term regtech adoption and monitoring implementation.[300] If the regtech solution relies on external sources for successful implementation - such as market participants for data input - the solution may also have to be properly adopted by market participants to allow regulators to ultimately reap the benefits of any investments.

Extended periods between initiation and implementation can further restrain investment of limited resources by regulatory bodies. For example, in India, the RBI struggled to gain support internally and externally for regtech development because of the limited number of similar regtech success stories to 'sell' internally the benefits of the proposed initiatives.[301] Even after initiatives were approved, the process of budget deployment took a long time given the complex layers of bureaucracies prevalent in India.[302]

6.3. Context

Central banks have and continue to use legacy technologies such as Excel and XML templates for reporting in regulatory processes.[303] Given technological and process improvements, these processes can be made more efficient and effective by using newer technologies[304] and processes offered by regtech.[305]

Central banks will however have to consider impact on legacy technologies, culture, infrastructure and workforce skills to determine the appropriate regtech solution for their needs, and develop a clear adoption plan.[306] These considerations may place limitations on the regtech innovation or at the least, complicate the development process. For example, central banks may have to consider the transfer of large volumes of data from legacy technologies to regtech domains or provide access to data still stored in legacy technologies even after the adoption of regtech.

Ironically, adoption of regtech may be relatively easier though in developing countries where legacy technologies and supervisory processes are not deeply ingrained in the financial systems and are easier to disconnect from the system and undertake upgrades.[307]

In developing countries, regtech solutions may assist FIs and fintech firms such as DFSPs in maintaining compliance.[308] But many regtech rely on large volumes of data which are usually obtained through FIs to develop necessary oversight tools, which is hard to gather in developing countries where there is lack of uniform bank

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[300] KPMG (2016) *Regulatory Technology Services (Regtech)*, available at https://bit.ly/2v54zlv; Deloitte (2017) *The Future of Regulatory Productivity, Powered by Regtech*, available at https://bit.ly/2vFeVr7

[301] Based on conversation with RBI.

[302] *ibid*

[303] Summary based on conversation with RBI, NRB, CNVB, and information from Castri, S D, Grasser, M, Kulenkampff, A (2018) *Financial Authorities in the Era of Data Abundance RegTech Regulators and Suptech Solutions;* Dias, D & Staschen, S (2017) *Regtech and Digital Finance Supervision: A Leap into the Future*, available at https://bit.ly/2GThDQe

[304] See Exhibit 2: Key Technologies in Regtech Innovation

[305] Automated reporting platform in the Bahamas, Canada and Mexico as well as data input and pull approach in Austria, India, Philippines, Rwanda, See Exhibit 14: Summary of Regtech Use Cases, Annex A

[306] Tokc-Wilde, I (2018) *In A World of Ever Increasing Regulatory and Reporting Requirements, New Technology Can Help Businesses Understand and Manage Their Compliance Risks Better*, available at https://bit.ly/2rhOILV; Leoni, F (2017) *Regtech Is Hard- But Nothing Worth Getting Was Ever Easy,* available at https://bit.ly/2EFLmWY

[307] Toronto Center (2017) *FinTech, Regtech and SupTech: What They Mean for Financial Supervision*, available at https://goo.gl/R3vWxH

[308] See Section 2.2: Regtech for Market Participants, Section 3.2.4 Market Participants

infrastructure and proper identification documents.[309] Similarly, regtech adopted by central banks may also require data input from market participants. It would then be necessary for the regtech solution to be accessible to required market participants regardless of their existing processes and IT systems.[310] Achieving this may however be particularly challenging if there is heterogeneity in the IT systems of market participants.

6.4. Capacity

6.4.1. Overview

As opposed to legacy technologies, regtech may allow central banks to receive information in real-time from market participants, creating more opportunities to detect anomalies in transactions and prevent mishaps.[311] Externally-focused regtech - which may improve processes that involve both the central banks and market participants - mostly relies on market participants to provide data and central banks to use the data for supervisory purposes.[312] Internally-focused regtech on the other hand may require collaboration amongst the different departments within the central bank to improve the central bank's internal functions, which may range from financial industry oversight to development of financial infrastructure. Regardless of the scope of the regtech solution, to benefit from it, both the central bank and – where applicable – market participants need to build staff capacity in new areas of required emerging expertise.[313]

6.4.2. Capacity of Regulators

Central banks need to build capacity to understand and properly use the technology. If the regtech solution automates data collection and validation or even collects granular data such as real-time or item-by-item information for financial activity, central banks need to focus on analytical and technical capabilities to extract actionable insights from this data.[314] In a data-driven environment, central bank's human capital needs may shift from staff that manually collect and handle data for analysis to data scientists who analyze automatically collected, processed, and/or validated data.

This means that different skills may be required from any supervisory staff than what was needed when dealing with legacy technologies. The technology-focus may thus require a marked improvement in central banks' technical competencies beyond their initial non-IT training. Provision should also be made for outsourcing acquisition of qualified staff to specialized employment agencies, in-country and abroad, as well as budgeting for relocation expenses for staff brought in from abroad. Additionally, central banks may be required to attract, retain and deploy IT engineers focused on developing and maintaining regtech solutions and a scrum for specific expertise which usually involves competing with the salaries and benefits provided by the tech industry.[315]

To wit, even though regtech may improve effectiveness and efficiency of central banks by automating processes or increasing transparency, the impact of any regtech advances may be limited without the required capacity and technical competency of central banks to understand the technologies and their limitations, properly and efficiently analyze output data and then synthesize policy decisions therefrom.

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[309] Likar, T (2017) *Emerging Market Payment Requires Innovation in Regulatory Technology,* available at https://bit.ly/2JEz2dn

[310] Enriques, L (2017) *Financial Supervisors and Regtech: Four Roles and Four Challenges*, available at https://goo.gl/akR8by

[311] Patel, B (2017) *How Suptech Will Revolutionize the Regulatory Watchdogs*, available at https://bit.ly/2HR989a

[312] See Section 2.3: Regtech for Regulators

[313] FSB (2017) *Regulatory and Supervisory Issues from FinTech,* available at https://bit.ly/2FFeT3M

[314] Piechocki, M & BearingPoint (2016). *Data as A Critical Factor for Central Banks*, available at https://bit.ly/2JMLTJN

[315] Enriques, L (2017) *The HR Challenge of FinTech for Financial Regulators*, available at https://bit.ly/2t9YUZS

6.4.3. Capacity of Market Participants

Regtech adoption can be a challenge for market participants if they do not have the required skill, budget and capacity to implement it. Since both central banks and market participants play distinct roles in the adoption of externally-focused regtech, inability of market participants to adopt regtech can reduce its usefulness for central banks.

If market participants are unable to adopt a reporting solution, it is trite that they will not be able to provide relevant data and information to the central bank's solution, undermining the solution itself. Without data and information from market participants, the solution may not have sufficient data inputs to support supervisory responsibilities of the regulator. From the participant's perspective, inability to adopt the solution may put it at a disadvantage compared to other market participants who adopt the solution. The solution may, however, be made mandatory by the central bank. Such 'teething' challenges can be particularly prominent in smaller market participants – such as DFSPs – as they may not have financial and human resources to introduce a new technology into their business.

6.5. Procurement

Central banks can outsource regtech development to TSPs, and the process of selecting a TSP and monitoring their progress can be performed by the central bank or a government wide IT procurement agency.[316]

Regardless of who undertakes procurement evaluation and execution, the team will need skilled human capital who understand both the central bank's needs and processes as well as the potential and workings of technology.[317] It will require project managers with procurement experience to outline and design the procurement process, content creators to produce RFIs and request for RFPs; administrators to monitor submissions; help desk operatives to answer any questions related to the procurement process; auditors with knowledge of central bank's needs; technical experts to validate and assess the information delivered by TSPs, contractors to formulate robust contracts; and senior level management with authority to finalize procurement decisions.[318]

In developing countries, information gathered from market participants indicates that there are challenges dealing with procurement teams, as there may not be skilled individuals within the central bank that understand technology, nor within government wide-IT procurement agency that understand central bank's processes or TSP capabilities.[319] TSPs may be inadvertently excluded from the procurement process because of capacity gaps, or worse, financial inducements to favor certain TSPs. These challenges are heightened when there is lack of collaboration and communication between central bank departments, procurement teams – internal or external – and TSP.

6.6. Sustainability

Due to anticipated large funding requirements[320] for regtech solutions and the generally limited resources of central banks in developing countries, many may seek and have sought assistance from donors and consultants to fund and catalyze potential solutions.[321] Assistance – which can take the form of financial resources, gap analysis, or expert advice – can act as a driving force in spearheading regtech initiatives.

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[316] digiwhist (2018) *Procurement Agencies,* available at http://digiwhist.eu/resources/procurement-agencies/

[317] Spend Matters (2015) *Knowledge Management in Procurement Organizations,* available at https://bit.ly/1yjQ7zy

[318] NC State University (2011) *Role of Procurement within an Organization: Procurement: A Tutorial*, available at https://bit.ly/1UX99ay

[319] Musanzikwa, M (2013) *Public Procurement System Challenges In Developing Countries: The Case Of Zimbabwe*, available at https://bit.ly/2FFxlcl; Tukuta, M & Saruchera, F (2015) *Challenges Facing Procurement Professionals In Developing Economies: Unlocking Value Through Professional International Purchasing*, available at https://bit.ly/2yusWbn; Bolton, P (2016) *Public Procurement as a Tool to Drive Innovation in South Africa*, available at http://tiny.cc/d46c0y

[320] See Section 6.2: Cost

[321] See Exhibit 5: Key Regtech Ecosystem Participants, Section 3.2.1: Donors and Section 3.2.2: Consultants

Significant influence of external parties in these initiatives may however lead to artificial dependency on donors and consultants.[322] Continuous involvement of external parties is thought by many interviewees we consulted to be unrealistic in so far as the long-term success of any regtech initiatives and subsequent solutions may be impacted by their exit. An illustrative approach that balances the long-term dependency concerns with the need to provide the catalytic impetus is the R2A initiative, which works with central banks and TSPs to develop regtech solutions and mitigate dependency challenges with the involvement of regulators in the development process.[323] The process of engagement also requires the governor of the central bank they cooperate with to sign a project charter commitment that prescriptively outlines the roles and responsibilities of all participants.[324]

6.7. Security

Technological developments are expected to improve cyber-security globally but developing countries with emerging levels of technological components, such as DFS, may not be prepared to secure their infrastructure as digital access increases.[325] Addressing cyber-risks, especially those that arise from fintech, has become so critical that the FSB has included monitoring of cyber-risk from fintech companies in its 2017 work plan, while the BIS has issued a guidance for cyber resilience in financial market infrastructure[326] to establish consistency in ongoing efforts.[327]

These may assist developing countries in securing their financial system but the growing use of technology in the financial sector coupled with the lack of proper network, security and legal framework leaves developing countries vulnerable to cyber threats.[328] National and regional Computer Emergency Readiness Team may assist in thwarting and preventing cyber stacks. The cyber-attacks though on Bangladesh Bank[329] as well as on the Central Bank of Russia[330] has highlighted the potential for vulnerabilities in current systems. Regtech adoption by central banks in developing countries increases reliance on technology and can place additional data-handling responsibilities to the central banks. Proper cyber security and cyber-resilience measures are hence crucial for secure regtech implementations.

7. Regtech for Financial Inclusion

7.1. Overview

DFS plays a key role in achieving financial inclusion goals in developing countries.[331] By reducing costs and offering basic financial services at greater convenience, it has increased financial access in rural and underserved populations.[332] The digitization of financial services and the characteristics of the new consumer base can, however,

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[322] IMF (2009) *The Challenge of Reforming Budgetary Institutions in Developing Countries,* available at http://tiny.cc/746c0y

[323] Accenture (2017) *How FinTech is Changing the Regulatory Environment: Compliance Keynote at Next,* available at https://goo.gl/RmV1Ze

[324] Based on conversation with USAID

[325] Microsoft (2014) *The Cybersecurity Risk Paradox*, available at https://bit.ly/K3O5gW

[326] Systems among FIs responsible for clearing, settlement and recording or financial transactions such as payments, securities and derivatives. FED (2018) *Supervision & Oversight of Financial Market Infrastructure,* available at http://tiny.cc/i56c0y

[327] BIS (2017) *Regulatory Approaches To Enhance Banks' Cyber-Security Frameworks,* available at http://tiny.cc/i66c0y; BIS (2014) *Cyber Resilience In Financial Market Infrastructures,* available at https://www.bis.org/cpmi/publ/d146.pdf

[328] Norwegian Institute of International Affairs (2018) *Cyber Security Capacity Building in Developing Countries*, available at https://bit.ly/2GUEiaV; Butler, K & Traynor, P (2015) *Security and Privacy Challenges for Mobile Money Applications,* available at https://bit.ly/2IJV1OL

[329] Gopalakrishnan, R & Mogato, M (2016) *Bangladesh Bank Official's Computer Was Hacked To Carry Out $82 Million Heist: Diplomat,* available at https://goo.gl/FY8DC8

[330] Kirk, J (2016) *Reports: Hackers Steal $31 Million from Russia's Central Bank*, available at https://bit.ly/2HRnW3w

[331] Atluri, V & Cracknell, D (2017) *Progress and Challenges with KYC and Digital ID,* available at https://bit.ly/2gBr72I

[332] CGAP (2018) *Digital Financial Services*, available at http://tiny.cc/666c0y

raise CIV and customer adoption concerns.[333] Risk-based rules on transaction limits and AML/CFT requirements can address some of these underlying risks.[334]

The interdisciplinary nature of DFS products, however, complicates supervision responsibilities. Regulators such as the central bank, financial intelligence unit (FIU) and a telecommunications authority are all involved in the regulation of DFS.[335] The need to coordinate between these and other regulators and monitor new market participants and technologies places additional responsibility on regulators. While regtech has been adopted in developing countries to assist central banks in carrying out their responsibilities, many of the solutions do not have specific DFS or financial inclusion objectives.[336] Regtech though has the potential to support regulators in this changing environment by directly impacting the supervision of the DFS ecosystem to maintain financial stability, integrity and inclusion.

Regtech can address critical DFS processes such as agent monitoring. For example, the Central Bank of Nigeria (CBN) formulated an agent banking database to collect information on all agents used by banks and DFSPs.[337] The agents are assigned a unique code associated with their identification, location, status, transaction volumes and values.[338]

Similarly, regtech is being used to promote financial inclusion. For example, Nepal's central bank, Nepal Rastra Bank (NRB) via funding from UNCDF launched a Financial Inclusion Portal to track financial inclusion progress in the country.[339] It provides real-time information and data to map financial access and usage to identify gaps in provision.[340] The MM4P programme initiative from the UNCDF also developed a smartphone app called 'NRB Data Collect' that allows FIs to upload necessary data along with geo-spatial information for each service point.[341] This initiative is anticipated to support data analysis and policy making, *inter alia* by assisting NRB to prioritize approval of new bank branches and track their financial inclusion progress, as well as determine ideal numbers of agents required to do so.[342]

Moreover, since there are multiple regulators and interdisciplinary processes, DFSPs constantly need to report the same information to different departments within a regulator and/or also to other authorities outside the financial sector. For example, in Tanzania, non-bank DFSPs need to report all transactions to the Tanzania Communications Regulatory Authority as well as the Bank of Tanzania.[343] Regtech has been used to automate reporting processes but the technologies have been developed in isolation by specific authorities or functions within authorities.[344] The

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[333] ADB (2016) *Financial Inclusion in the Digital Economy,* available at https://bit.ly/2wRz2mx

[334] Buckley, R (2017) *Regulating Digital Financial Services to Promote Financial Inclusion,* available at http://tiny.cc/i76c0y

[335] CGAP (2015) *Digital Financial Inclusion: Implications for Customers, Regulators, Supervisors, and Standard-Setting Bodies,* available at http://tiny.cc/376c0y

[336] See Exhibit 14: Summary of Regtech Use Cases

[337] CBN (2018) *Guidelines for The Regulation of Agent Banking and Agent Banking Relationships in Nigeria,* available at https://goo.gl/i7zTb3

[338] *ibid.*

[339] *See www.emap.nrb.org.np*

[340] See Annex G: Regtech Use by the NRB

[341] *ibid.*

[342] *ibid.*

[343] Dias, D & Staschen, S (2017) *Data Collection by Supervisors of Digital Financial Services*, available at https://goo.gl/YHB4w3

[344] See Section 4.1: Collaboration Between Industry, Ecosystem Participants, and Regulators, Section 5.7: Improvement and Integration of Internal Processes

involvement of multiple authorities however creates opportunities for collaboration in streamlining regulatory processes.[345]

Collaboration among regulators to use regtech as means to collect and share data can levitate reporting burden for market participants, while facilitating development of a more robust system. MAS and FS-ISAC are establishing APAC Regional Intelligence and Analysis Centre to promote sharing and analysis of cyber-security information within the financial sector for real time monitoring.[346]

Moreover, market participants have also established partnerships to set up KYC utilities[347] to share customer's personal information,[348] and regulators are also doing the same – MAS partnered with the Singaporean Ministry of Finance and its Government Technology Agency to set up a national KYC utility called MyInfo.[349]

Partnerships amongst regulators for 'KYC Utility' can benefit the DFS ecosystem by reducing duplicate CIV processes for DFSPs and establishing industry standards through a centralized database.[350] The reduction in cost from undertaking centralized CIV processes, information from multiple sources across the industry and availability of data for a broader range of customers can encourage provision of services to customers, who may or may not have had the opportunity to access financial services before due to their inability to meet KYC and CDD requirements.[351]

For those unable to meet stringent CDD requirements, simplified CDD[352] in DFS provides limited access to financial services[353] through proportionally lower transaction and wallet/account balance limits compared to those that are fully CDD compliant.[354] While this may glacially increase financial inclusion, until a robust CDD monitoring regime is put in place, there is still the potential for exploitation through smurfing[355] to undertake ML. There is hence a need for holistic supervision of DFS through the use of regtech solutions such as shared utilities that span across multiple aspects of DFS.

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[345] See Section 4.1: Collaboration Between Industry, Ecosystem Participants, and Regulators

[346] See Exhibit 7: MAS and FS-ISAC Collaborate for Cybersecurity Information Sharing

[347] See Section 7.2: Shared Utilities as Regtech

[348] Finextra (2018) *Trulioo Releases Kyc Tool for Mobile Operators,* available at https://bit.ly/2HRaYH6; HIS Markit (2018) *KYC Services,* available at http://tiny.cc/l96c0y; SWIFT (2016) *The KYC Registry,* available at https://bit.ly/2GB10sz

[349] See Exhibit 15: Singapore- MyInfo KYC Utility, McKenze, B (2016) *What's Next in Singapore's Journey?*, available at https://goo.gl/88jQnP

[350] Dunphy, J (2014) *KYC Utilities and the Future of Regulatory Onboarding,* available at https://bit.ly/2d42ihf

[351] LexisNexis Risk Solutions (2016) *Financial Transparency and Inclusion White Paper,* available at https://bit.ly/2jsN1Hc

[352] Also referred to as Simplified Due Diligence, simplified CDD are less strict CDD process based on the customer's risk profile. Less information or less robust verification of the customer's identity and their intentions behind the business relationship may be required or verification may be postponed. It can ease difficulties for people to access financial services. FATF (2014) *Guidance for Risk-based Approach: The Banking Sector,* available at https://bit.ly/1thpYyY

[353] Owens, J (2018) *Offering Digital Financial Services to Promote Financial Inclusion: Lessons We've Learned,* available at https://www.mitpressjournals.org/doi/pdf/10.1162/INOV_a_00179; Atluri, V & Cracknell, D (2017) *Progress and Challenges with KYC and Digital ID,* available at https://bit.ly/2gBr72I

[354] Atluri, V & Cracknell, D (2017) *Progress and Challenges with KYC and Digital ID,* available at http://blog.microsave.net/progress-and-challenges-with-kyc-and-digital-id/

[355] Also known as structuring, smurfing is the breaking up financial transactions into multiple smaller amounts in order to avoid reporting requirements set at a specific transaction limit. Summarized from IRS (2016) *4.26.13 Structuring*, available at http://tiny.cc/w96c0y; Linn, C (2010) *Redefining the Bank Secrecy Act: Currency Reporting and the Crime of Structuring,* available at https://bit.ly/2qrGIaW

7.2. Shared Utilities as Regtech

Collaboration amongst participants in the DFS ecosystem for regtech can take the form of a shared utility. One iteration – generally known as a 'KYC Utility'[356] – would aggregate compliance and supervision functions. Ideally a KYC Utility can integrate all or some of CIV and CDD processes including sanctions screening, transaction limit checks as well as velocity checks.[357]

Input data may be provided by market participants and then outputted for real-time analysis by regulators for oversight purposes. There would be qualified access to such a utility, devised on a cost recovery basis, which participants paying only for the (utility) services they use.[358] If the customer's personal data in the utility is linked to accounts, data from these accounts could be obtained from market participants for regulatory oversight and monitoring but personal, identifiable data masked through what is known as 'hashing.'[359]

Regulators could extract the data they need from the central utility rather than requiring DFSPs to individually report the same data to each regulator, and also possibly in different data formats.

MyInfo is a personal data platform developed by Singapore's Ministry of Finance and its Government Technology Agency.[360] It can be accessed by SingPass[361] users to manage their personal data and pre-fill forms in digital services transactions.[362] Data from other participating government agencies may be retrieved and added to the user's profile along with the data the users specifically provide.[363] The profile of the users contains personal, income, education, employment, family and contact information.[364]

MAS recognizes MyInfo as a valid form of non-face-to-face customer identification and verification.[365] FIs do not have to obtain additional documents to verify a customer's identity if their MyInfo data is provided. Users will thus only have to provide their personal information to the Government once. They will also not have to fill forms and verify documentations as often since the data can be directly accessed

[356] The concept of KYC Utilities is commonly considered to be a central repository to streamline the collection and exchange of customer identification data between member institutions, while maintaining appropriate privacy controls. Summarized from PwC (2015) *Share and Share Alike: Meeting Compliance Needs Together With A KYC Utility,* available at https://pwc.to/2IOl7Aa; CITI (2014) *Know Your Customer Utilities,* available at http://citi.us/2HtqUvy

[357] On shared KYC utilities, see Lyman, L; Soursourian, M; De Koker, L et al. (2018) *Collaborative Customer Due Diligence: New Ways Forward*, available at https://bit.ly/2OOEKic; and Perlman, L & Gurung, N (2018) *The Use of eIDs and eKYC for Customer Identity and Verification in Developing Countries: Progress and Challenges*, available at www.dfsobservatory.com

[358] Thomson Reuters (2015) *KYC: Are Shared Utilities The Answer?,* available at https://tmsnrt.rs/2IN21u9

[359] Hashing is one-way encryption method using hash functions that computer a fixed-length hash value as outcomes based on the inputted data. It is impossible to contents and length of the inputted data to be recovered, allowing for integrity. Northcutt, S (2018) *Hash Functions,* available at https://bit.ly/2Hukso9

[360] MyInfo (2018) *MyInfo*, available at https://www.singpass.gov.sg/myinfo/intro

[361] An online account management system that allows users to access Singapore Government e-services easily and securly, SingPass (2018) *About Us,* available at https://www.singpass.gov.sg/singpass/common/aboutus

[362] MyInfo (2018) *MyInfo*, available at https://www.singpass.gov.sg/myinfo/intro

[363] MyInfo (2018) *Frequently Asked Questions*, available at https://bit.ly/2qwJ1JZ

[364] MyInfo (2018) *MyInfo*, available at https://www.singpass.gov.sg/myinfo/intro

[365] MAS (2018) *MAS Encourages Financial Institutions to Use Technology to On-board Customers More Efficiently,* available at https://goo.gl/z8MkPy

through MyInfo.[366] But, not all data is available to all market participants as the users have control over the sharing of their data.[367]

Exhibit 15: Singapore – MyInfo KYC Utility

For market participants to successfully authenticate and push data to the utility and for regulators to pull data from the utility, they need to have common technologies, which are usually achieved through APIs, made available such that all involved parties can access existing infrastructure in a cost effective and time efficient manner.[368]

Ideally, the shared utility can be established through the collaborative initiatives of the regulators and private utility manager. The joint tendering of such systems, however, can be difficult considering that regulators have their own objectives, bureaucracies and biases.

7.2.1. Identity Verification

Identification is obtained from new users or inputted by market participants into the utility. Following the first entry, market participants can use the utility to authenticate the user's identity without completely accessing all the information on the database. This is a similar system to that of Aadhaar, a project operated and managed by the Unique Identification Authority of India (UIDAI) that provides a formal and unique identity number to residents of India after a verification process as per the policy, procedures and system laid by the authority.[369] The Aadhaar number is linked to an enrollee's demographic and biometric information which is stored in a centralized system to ostensibly reduce de-duplication and fake identities.[370] Up until a court ruling in September 2018, users were able to open bank accounts, obtain SIM cards, and enroll in DFS using their Aadhaar number. By addressing the issues related to lack of documentation and access to physical banking services, the system has encouraged financial inclusion in India.[371] Nevertheless, security concerns are still prominent, especially after the emergence of multiple claims of Aadhaar data breaches.[372]

7.2.2. AML

The Bank Verification Numbers (BVN) project by CBN provides a unique identification number to users for use in conducting banking transactions and maintains a watch-list of all BVNs associated with fraud which FIs can access while verifying identities.[373] A similar cross-checking anti-money laundering processes may be useful in the utility. The process could check sanctions, black lists and geography of users to identify risks for the market participants

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366 MyInfo (2018) *About Us*, available at https://www.singpass.gov.sg/myinfo/common/aboutus

367 *ibid.*

368 Trulioo (2017) *API-driven Solutions for KYC Compliance – FinTech Innovation*, available at http://tiny.cc/ta7c0y

369 UIDAI (2016) *About Aadhaar*, available at https://uidai.gov.in/your-aadhaar/about-aadhaar.html; UIDAI (2016) *About UIDAI,* available at http://tiny.cc/ta7c0y; In September 2018, a 5-judge constitutional bench of the Supreme Court of India ruled that Aadhar was constitutional, but restricted its use in a number of cases. It ruled that Aadhaar is mandatory for filing of income tax returns and allotment of Permanent Account Numbers and must be used for access to welfare schemes and government subsidies. Aadhaar data cannot however be used for KYC procedures by banks. Similarly, MNOs cannot insist on Aadhar details when buying a new SIM card. See further Livemint (2018) W*hat Supreme Court's Aadhaar Verdict means for you: 10 points*, available at https://bit.ly/2Om0brG; and and Perlman, L & Gurung, N (2018) *The Use of eIDs and eKYC for Customer Identity and Verification in Developing Countries: Progress and Challenges*, available at www.dfsobservatory.com

370 *ibid.*

371 Abraham, R, Bennett, E, Sen, N, et al. (2017) *State of Aadhaar Report 2016-2017*, available at https://bit.ly/2HQc8hE

372 The Tribune (2018) *UIDAI Denies Breach of Aadhaar Data*, available at https://bit.ly/2AqhGeq. The Tribune newspaper in India, even claimed that it was able to purchase unrestricted access to details of more than 1 billion Aadhaar numbers over Whatsapp. Cited from Khaira, R (2018) *Rs 500, 10 Minutes, And You Have Access To Billion Aadhaar Details,* available at https://bit.ly/2E4qEjK

373 See Annex F: Regtech Use by the CBN

authenticating the identity of the user and the regulators monitoring the financial sector. This would provide a more holistic view of the user and assist in determining the risks they pose.

7.2.3. Limit Checks

Transaction account limits associated with each identification document could be inputted by the industry and stored in the utility. There may be daily, weekly and/or monthly limits on DFS transactions based on the jurisdiction. Since DFS transaction limits are low compared to other formal financial services such as bank accounts, limits could be monitored to ensure that the user is not exceeding them.

7.2.4. Velocity Checks

Even when transactions are within limit, the utility could store the frequency of transactions. Smurfing is a common phenomenon where financial transactions are broke down and executed in a specific pattern to avoid raising suspicion of money laundering.[374] Frequency can thus be monitored and high frequency and/or identifiable patterns of financial transactions using DFS could trigger suspicious activity alerts.

8. Conclusions

Regtech adoption in developed countries has been mainly driven by the rising compliance costs whereas adoption in developing countries tracks increases in responsibilities of central banks in keeping up with new technological developments such as DFS as well as the changing characteristics of market participants.

Despite the differences with developed countries, regtech has managed to greatly assist central banks in developing countries by improving existing systems and providing new tools for supervision. Regtech can, however, further assist central banks in achieving their financial stability, safety, integrity and inclusion objectives. Newer technologies such as DLT are still being explored in the regulatory context. These new applications can benefit central banks in fulfilling their oversight responsibilities in an efficient and effective manner.

The use of regtech to strengthen supervisory capacities of central banks can indirectly impact financial inclusion but central banks are also exploring ways in which regtech can directly improve DFS and financial inclusion.

Successful regtech adoption is, however, determined by factors that are more than just the ability of the technology to meet the needs of the central bank.[375] In developing countries, the financial, social and political situations can pose unique and pronounced challenges for central banks while adopting regtech.[376]

The realities of developing countries – low penetration of formal financial services, low income and financial literacy, underdeveloped technology ecosystem and weak infrastructure – raises concerns and doubts in regtech adoption. The challenges relate to the high up-front cost of regtech, integration with existing industry systems and processes, capacity of both central banks and market participants to use the technology in the intended manner, need for proper cyber-security measures and overdependence on external contributors such as donors and consultants.

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[374] IRS (2016) *4.26.13 Structuring*, available at https://www.irs.gov/irm/part4/irm_04-026-013; Linn, C (2010) *Redefining the Bank Secrecy Act: Currency Reporting and the Crime of Structuring,* available at https://bit.ly/2qrGIaW

[375] See Section 4: Factors in Regtech Development and Use, Section 6: Challenges for Regtech Development in Developing Countries

[376] See Section 6: Challenges for Regtech Development in Developing Countries

Legacy Challenges/Issues	Regtech Solutions
Monitoring in lag time affecting response of regulators	● eal-time data monitoring of structured and unstructured data for purposes such as detecting non-compliance and money laundering
Large volumes, velocity and variety of data exceeds analysis capacity	● I and advanced analytics to predict risks from large data sets and address them in a timely manner
Human errors in manual data reporting	● btain granular data without human intervention directly from IT systems of market participants ● ntegrate data validation and quality control checks in submission forms to identify faulty entries
Large amounts of time spent on manually processing obtained data	● utomatic data processing that provides both general trends and detailed analysis for regulators
Isolated IT systems of the regulators and market participants	● sing APIs to integrate market participants' IT system with the regulator's Regtech system to allow for easier reporting and compliance
Different regulators requiring the same data in different formats	● ollection of market participants' data in a central repository and sharing of data with participating regulatory bodies
Limitations in hardware and software capacity	● toring, managing and processing data in remote and shared servers through cloud based services
Need to interpret and adapt systems to changing regulations	● rovisions for identifying and interpreting appropriate regulations and integrating them directly into the market participant's IT system ● sing DLT to develop a financial infrastructure where regulators can incorporate regulations as rules of the ledger
Isolated heterogeneous processes within a regulator	● ntegrating internal processes into a digital architecture for standardization and ease in coordination amongst functions within the regulator

Exhibit 16: Summary of Challenges and Issues with Legacy Technology and Potential Regtech Solution

9. Recommendations

To overcome such challenges and harness the benefits of regtech, central banks in developing countries should:

- Facilitate discussions to identify potential use cases of regtech to improve internal functions of central banks
- Initiate dialogue with regtech ecosystem participants to understand what kind of compliance issues market participants face, and how they can improve their regulatory processes to reduce burden on market participants
- Explore ways in which a regtech solution can be used by other functions within the central bank and by other regulators to avoid development of multiple isolated regtech with similar objectives
- Understand existing and emerging innovations through initiatives such as regulatory sandboxes
- Formulate a road map for regtech adoption that outlines the regtech procurement, development, and implementation process along with measures taken to ensure it is used properly
- Outline clear responsibilities between involved parties in the development process – regulators, donors, consultants, TSPs – to avoid conflict
- Engage in capacity building of central banks so that they are able to adapt, and use regtech even after the withdrawal of external assistance
- Ensure adoption by market participants, where applicable, through development of interoperable systems, provision of API, and/or increase in their capacity, among many other methods
- Collaborate with other regulators within the same jurisdiction to establish common regtech solutions such as shared utilities to streamline data collection, centralize storage, standardize solutions, and distribute high up-front costs of regtech
- Establish agreements with regulators across jurisdiction to share regtech knowledge, resources and innovations in order to identify new opportunities for regtech use
- Strengthen data security and privacy measures before deployment of regtech to protect the financial sector

Annex A: Interviewees

- Banco Central do Brasil
- Bank of Russia
- Comision Nacional Bancarias y de Valores, Mexico
- Compliant Risk Technology
- Monetary Authority of Singapore
- Nepal Rastra Bank
- R2A
- Reserve Bank of India
- Rwanda Utilities Regulatory Authority
- USAID
- Vizor Software
- World Bank

Annex B: Regtech Use Cases in Developed and Developing Countries. The table presents the specific problems regtech solutions address and their characteristics and capabilities to showcase the developments in different countries.

Country	Regulator	Problem	Regtech Solution	Year	Donor/ Consultant
Austria[377]	Oesterreichische National Bank	There exists a lack of harmonization in data collection and IT systems between regulator and banks.	A joint venture called Austrian Reporting Services (AuRep) was founded by Austrian banks to act as a central interface for regulatory reporting. It was developed by BearingPoint and uses a data input approach to collect granular data from banks. Data is submitted by banks in the form of data cubes and AuRep transforms them into smart cubes which consist of data that are organized as per the bank's business type and formatted as per the requirements of the regulators.		
Bahamas[378]	Central Bank of The Bahamas	The reporting system was outdated and did not allow for information sharing with other regulators.	The Online Reporting and Information Management System (ORIMS), developed by Vizor, improves the Central Bank's data collection, validation, storage and reporting	2015	

[377] See Exhibit 9: Austria- OeNB Collects Granular Data Using AuRep

[378] Vizor (2015) *Central Bank of the Bahamas Launches Online Reporting & Management System with Vizor,* available at https://bit.ly/2GUNBYu

			functionality. It also expanded their business intelligence and data analytics capabilities. Vizor worked with the Securities Commission of the Bahamas and the Insurance Commission of the Bahamas to improve their reporting systems.[379] They were able to align the reporting infrastructure of the three regulator bodies.[380]		
Canada[381]	Bank of Canada, Office of the Superintendent of Financial Institutions, Canada Deposit Insurance Corporation[382]	Regulators had to collect many forms from market participants, process large volumes of complex data and act as per the results in a timely manner. Due to the current manual processes and inflexible IT systems, regulators spent a lot of time collecting and preparing data.	Vizor Regulatory Reporting System was implemented in Canada. It allows for quality data collection and analysis. The responsibility is placed on the FIs to provide correct and timely data and the system consists of features such as rules and validations to assist them. It also analyzes the collected data and makes it available for	2014	

[379] Central Banking (2017) *Technology Provider of the Year (Supervision): Vizor Software*, available at https://bit.ly/2vdajd8
[380] *ibid.*
[381] Vizor (2018) *Vizor Regulatory Returns*, available at https://vizorsoftware.com/regulatory-returns/
[382] Central Banking Awards (2017) *Technology Provider of the Year (Supervision): Vizor Software,* available at https://bit.ly/2HfQQNr

			assessment and reporting immediately.		
Ghana[383]	Bank of Ghana			Discontinued	Regtech for Regulators
India[384]	Reserve Bank of India (RBI)	RBI relied on manual reporting process which was slow and susceptible to human errors. The data was also obtained in lag time so RBI could only assess situations after they occurred.	A feedforward system was implemented where data is directly obtained by RBI from the FIs' systems. Using predictive analysis on the obtained data, RBI was able to act on potential issues before they occured or in real time.	~2016	Yes

[383] R2A (2017) *Leading Financial Authorities Kick Off Partnership that will Apply Best in FinTech to Supervision, Regulation and Policymaking,* available at http://tiny.cc/hd7c0y

[384] See Annex C: Regtech Use by the RBI

Jamaica[385]	Bank of Jamaica	Demand for large volumes of data and detailed analysis to formulate regulation and ensure compliance.	The Jamaica Financial Institutions Reporting Management System (JamFIRMS) improves data collection processes from internal sources, supervised institutions and other entities. It also includes a business intelligence component that provides Bank of Jamaica with both broad patterns and detailed analysis. By using the software, they are able to easily identify risks and reduce turnaround time for data analysis.	2017	
Mexico[386]	Comision Nacional Bancarias de Valores (CNBV)	Manual reporting of AML data leads to lengthy monitoring processes. A large amount of time is spent on cleaning and structuring data.	A new data infrastructure based on a central, access-controlled data storage platform. It stores data that supervised entities submit using APIs and also validates, processes, analyzes and reports data using machine learning, data analytics and visualization tools.[387]	Prototype by June 2018	Regtech for Regulators, Gestell[388]

[385] Vizor (2017) *Vizor Software Launched by Bank of Jamaica,* available at https://bit.ly/2HmaiIm
[386] See Annex E: Regtech Use by the CNBV
[387] Castri, S D, Grasser, M, Kulenkampff, A (2018) *Financial Authorities in the Era of Data Abundance RegTech Regulators and Suptech Solutions*
[388] *ibid.*

Nepal[389]	Nepal Rastra Bank (NRB)	A large portion of the population is still excluded from the formal financial system.	An e-mapping platform that maps all financial points in Nepal including banks, bank accounts, branches, and agents, to monitor transactions and prioritize development in areas where financial services are poor.	2017	UNCDF, MM4P
Nigeria[390]	Central Bank of Nigeria (CBN)	Numerous instances of identity theft and fraud.	Bank Verification Numbers (BVN) project aims to provide a unique identification number to users based on their physiological and behavioral attributes to be used for banking transactions. The centralized database is available for FIs to use in order to verify users. There is also a watch-list that collects all BVNs associated with fraud which is updated and used by FIs and maintained by Nigeria Inter-Bank Settlement System (NIBSS).	2014	

[389] See Annex G: Regtech Use by the NRB

[390] See Annex F: Regtech Use by the CBN

Philippines[391]	Bangko Sentral ng Pilipinas (BSP)	Manual reporting system requires banks to submit reports via email, which is inefficient and insecure.	Developing APIs and back office reporting and visualization application so that regulators can obtain raw data directly from the FIs IT system, validate data faster and facilitate analysis for supervisory and policy development purposes.[392]	Prototype by June 2018	Regtech for Regulators, Compliant Risk Technology[393]
Rwanda[394]	National Bank of Rwanda (BNR)	The financial inclusion agenda and data-driven culture in Rwanda requires data-driven monitoring of financial inclusion objectives. Moreover, with the diverse range of FSPs, BNR has to expand its supervisory scope and capabilities.	Along with Sunoida Solutions, BNR developed an electronic data warehouse (EDW) system. The system automates and streamlines the reporting processes. It allows BNR to pull data daily from the FSPs' systems and provides opportunities for real time monitoring. The system also allows Savings and Credit Cooperatives with poor IT systems to continue pushing data to BNR using excel templates.	2017	

[391] See Annex D: Regtech Use by the BSP

[392] Castri, S D, Grasser, M, Kulenkampff, A (2018) *Financial Authorities in the Era of Data Abundance RegTech Regulators and Suptech Solutions*

[393] *ibid.*

[394] Kamali, W & Randall, D (2017) *Leveraging 'Suptech' For Financial Inclusion in Rwanda*, available at https://bit.ly/2v7XHUv

			Rwanda Utilities Regulatory Authority (RURA) also has a similar system to monitor mobile money activities.[395]		
UK[396]	Financial Conduct Authority (FCA)	Frequent changes in rules increases burden on FIs to constantly interpret the rules properly and quickly. The variability in interpretations of rules amongst market participants also lead to incompliance.	Developing code for machine readable regulations that will allow changes to be automatically implemented in the FIs IT systems without human intervention and interpretation.	In progress	
USA[397]	Consumer Financial Protection Bureau	Lack of frequent interactions between regulators and consumers left a gap in the regulator's understanding of market issues.	Database of complaints that can be easily viewed and searched by market participants such that bad practices are identified and dealt with.	2011	

[395] Based on conversation with RURA.

[396] Nikolova, M (2017*) FCA, BoE Gear Up for TechSprint to Explore Advantages of Regtech*, available at https://goo.gl/GuLnR2

[397] See Exhibit 10: US Consumer Financial Protection Bureau Opens Access to New Information

Annex C: Regtech Use by the Reserve Bank of India (RBI)[398]

Regtech adoption by the RBI, Central Bank of India, is still in its nascent stages but it has managed to transform the monitoring and reporting processes for both FIs and PSPs. RBI previously required banks to submit reports in a specific format, which required manual intervention or intervention of a system to process the data. The new regtech initiative replaced the feedback system[399] with a feedforward system[400]. It extracts data directly from the banking systems, analyzes it, identifies exceptions, and evaluates the findings automatically.

The development of this regtech involved donors and external consultants. The high cost of implementation was an issue and continues to be an issue because there are doubts concerning the regtech's potential and success. It was particularly difficult to budget the project as regulators were only able to get feedback on the impact of the technology after testing the prototype. RBI worked with professional third party testers and auditors to make sure that the regtech does what it is expected to do, in a manner it is expected to do it.

Before the adoption of regtech, one of the biggest problems faced by market participants was the lack of coordination between regulators. They had to submit the same information to different regulators and functions in different formats and platforms. With the regtech extracting data directly from the market participants, they no longer have to deal with the different requirements of the regulators. It lifted reporting burden from market participants and ensured uniform security in data handling across the industry.

In order for the regtech to function properly, however,, market participants also need to adopt certain aspects of the regtech. Due to financial and human resource limitations, market participants may not be able adopt regtech. This raises major business and regulatory concerns. Those who are not able to adopt regtech may be left behind in the digitization process and can place them at a disadvantage. Moreover, without adoption, regulators are not able to use the regtech to obtain the necessary data directly from the market participants. RBI is looking to address this issue as regtech solutions evolve and become more established.

For the regulators, regtech adoption standardized the varying IT capacity of regulatory units which previously posed issues in internal coordination and security. The real time monitoring of data, however, overwhelmed RBI's staff as they were only used to receiving reports in lag time. Moreover, the RBI relied heavily on TSPs to deal with IT related issues and overdependence increased variability in proper implementation of regulatory processes.

A year into the initiative, regtech has benefitted both regulators and market participants while also creating opportunities for the private sector to be involved in regtech provision. There have been learnings that has emphasized the need to develop the knowledge base of all involved parties, to establish proper security measures for information exchange, and uniform reporting standards across different regulators and functions.

[398] Based on conversation with RBI official in 2017.

[399] Regulators are informed after the event has taken place

[400] Real time data monitoring by regulators to identify areas of concern which they can address quickly

Annex D: Regtech Use by the Bangko Sentral ng Pilipinas (BSP)[401]

The BSP, Central Bank of Philippines, is conducting a 20-month project for regtech adoption. It is divided into three phases – Phase 1 consists of a need assessment of the central bank to identify priority issues, Phase 2 engages innovators in the private sector to develop solutions that address the priority issue and Phase 3 involves provision of grants to innovators to test their idea.

The external parties involved in the regtech initiative, R2A – donors (Bill and Melinda Gates Foundation, Omidyar Network, USAID) and consultants (BFS global, RFA)– facilitated discussions within the bank to determine focus issues for the project. In order to involve the private innovators, they conducted a hackathon to address the issue of BSP. The prototype was scheduled to be delivered by June 2018 and currently, two pilot projects are underway.[402]

The first uses an API, back office reporting and visualization software that can automate BSP's tedious and insecure manual reporting and analysis system, which requires banks to submit reports via email. Using the API, regulators can plug into FI's IT systems to obtain raw data which they can validate and use to derive their own observations and conclusions. The new system may reduce compliance costs on FIs, increase quality and volume of data available for regulators, reduce late penalties by enforcing consistent and timely automatic submission and drive data driven supervisory and policy measures by providing near real time customizable reports to staff using charts, graphs and dashboards.

Furthermore, BSP is also working on an interface between regulators and consumers to handle complaints. The chatbot processes complaints and queries from consumers using natural language processing and machine learning to either respond directly or forward to the call center. The gathered complaint data is stored in a central database and can be used to better understand consumer trends for oversight and policy development. The insights can facilitate early detection of bad practices and unusual activity in the market. While the prototype is yet to be tested, it has the potential to scale into an AI driven system that also forward comments and feedbacks to providers.

The two prototypes are being developed by Compliant Risk Technology LLC & Pinecone Ltd.

[401] Based on conversation with USAID in 2017. For more information, see Castri, S D, Grasser, M, Kulenkampff, A (2018) *Financial Authorities in the Era of Data Abundance RegTech Regulators and Suptech Solutions*

[402] BSP Governor (2018) *Central Bank Evolution in the Digital Age,* available at https://bit.ly/2PPbjdd

Annex E: Regtech Use by the Comision Nacional Bancarias de Valores (CNBV)[403]

The national banking and securities commission of Mexico, CNBV, supervises and regulates the financial system. CNBV is implementing a regtech project to address issues in their AML supervision processes. The prototype of the regtech, expected to be developed by the end of May 2018, aims to automate the submission of AML compliance data by FI.

Currently, the process is handled manually and it can take 3 to 5 weeks to supervise an institution. The AML report is submitted to CNBV by FIs as a .txt file on CDs and the CNBV staff spend the first 2 weeks preparing and structuring the obtained data.

The new data infrastructure is expected to be an access-controlled data storage platform that stores data submitted by FIs digitally and automatically using APIs. Data will be processed and analyzed using machine learning models, advanced data analytics and visualization tool, leaving the supervisors with more time to improve supervisory quality and provide better guidance to market participants. To accommodate for the different technological capabilities of employees, the prototype will include user-friendly dashboards that generate customized reports for supervisory and policy development purposes. There will also be provisions for importing historical records into the centralized database in order to ease transition from legacy technologies.

The project is being implemented by the CNBV as part of the R2A. The AML issue was identified by consultants after a needs assessment of CNBV in the first quarter of 2017. Following the identification of the issue, a competition was conducted to select a TSP for the regtech solution. The winner of the competition, Gestella Heuristics, was awarded USD 100,000 to develop a prototype. Currently, the TSP is working with the regtech team in CNBV to gather more information on the regulatory processes. The findings may guide the development of the prototype.

In order for CNBV to completely adopt the regtech, the prototype will have to be approved by the Vice President. They are hopeful that the technology will allow them to implement risk-based AML supervision, reduce compliance costs and promote financial inclusion while maintaining financial integrity. If the prototype is approved, CNBV is committed to building the capacity of their staff to ensure success of the technology.

Even though the technology may increase volume, granularity and frequency of data, it still requires FIs to submit the data. The success of the technology is hence also dependent on the ability of FIs to adopt it. CNBV believes that it would greatly benefit from a system that allows them to access real time data directly from the regulated entities' system. The up-to-date information could allow them to predict and detect AML non compliance in a timely manner.

[403] Based on conversation with CNBV in 2017. For more information, see Castri, S D, Grasser, M, Kulenkampff, A (2018) *Financial Authorities in the Era of Data Abundance RegTech Regulators and Suptech Solutions*

Annex F: Regtech Use by the Central Bank of Nigeria

In 2014, CBN in collaboration with the banks in Nigeria introduced a system where they assigned users BVNs which is a unique identification number associated with a user's physiological and behavioral attributes (fingerprints, signatures, and other information) that can be used for bank transactions across Nigeria.[404] It not only aimed to protect customers from unauthorized access, identity theft and fraud but also identify blacklisted customers.[405]

The BVN project requires that the biometrics of an individual performing a banking transaction match the information on the central identification database.[406] Banks are hence required to verify the identity of the beneficial owner of an account by linking customers' BVN to their account and performing reasonable KYC procedures.[407] 46 million bank accounts however are still not linked to a BVN.[408]

Banks are required to publish accounts not linked to a BVN in the newspaper.[409] Once the accounts have been published, owners need to present a valid case as to why the funds in the accounts should not be forfeited.[410] This has placed a burden on FIs, by increasing its compliance operations. Furthermore, individuals need to be present in person to obtain a BVN.[411] This has raised controversy since 15 million Nigerians live abroad and there are only limited locations abroad to register for a BVN.[412] The BVN project is complimented by a watch-list with BVNs of customers who have been involved in confirmed fraudulent activities.[413] If a user commits fraud including not paying back loans, the BVN of the user is blacklisted. The watch-listed individual's activity can be tracked and the individual is prevented from applying for loans and accessing other financial services.[414]

The watch-list database is maintained by the Nigeria Inter-Bank Settlement System (NIBSS) on behalf of the stakeholders – CBN, NIBSS, Deposit Money Banks (DMB), FIs and Bank Customers.[415] NIBSS is not only in charge of updating the list but also in charge of developing a portal for banks to verify watch-listed individuals and API for institutions to integrate their system into the BVN system to validate the identity of individuals during the time of transaction.[416] This technology will require input of fraud data from FIs into the centralized database, the constant monitoring of the list by NIBSS and access to data for validation of identities. In order to make sure appropriate data is inputted, FIs that do not enlist individuals involved in fraudulent activities will be penalized.[417]

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[404] Central Bank of Nigeria (2017) *Bank Verification Number (BVN) Enrollment for Customers,* available at https://bit.ly/2HPgfip; Online Integrated Solutions (2018) *BVN Enrolment*, available at https://oisservices.com/bvn.php

[405] *ibid.*

[406] Esoimeme, E (2015) *A Critical Analysis of the Bank Verification Number Project introduced by the Central Bank of Nigeria,* available at https://goo.gl/RHsw5K

[407] *ibid.*

[408] Jannah, C (2017) *Presidency Speaks On Forfeiture of 46 Million Bank Accounts Without BVN*, available at http://tiny.cc/be7c0y

[409] Ibemere, D (2017) *5 things to know about FG BVN order*, available at https://goo.gl/CzQ423

[410] *ibid.*

[411] Esoimeme, E (2015) *A Critical Analysis of the Bank Verification Number Project Introduced by the Central Bank of Nigeria,* available at https://goo.gl/RHsw5K

[412] Ibemere, D (2017) *5 Things to Know About FG BVN Order*, available at https://goo.gl/CzQ423

[413] Azeez, K (2018) *80 To 90% Bank Fraud Caused by Customers – NIBSS Boss*, available at https://bit.ly/2IMRejB

[414] *ibid.*

[415] CBN (2017) *Regulatory Framework for Bank Verification Number (BVN) Operations and Watch-List for the Nigerian Banking Industry*, available at https://goo.gl/nVbwFF

[416] *ibid.*

[417] *ibid.*

BVN has also faced legal challenges by the National Identity Management Commission (NIMC). NIMC claimed that they had the sole rights for biometric registrations and verifications and contested the right of the CBN to register citizens using biometric information and to issue the BVN.[418] An agreement was reached that requires harmonization of BVN database with the new National Identity Database (NIDB).[419] Other qualified databases with biometric eKYC measures are also eligible for harmonization until December 1, 2018.[420] Following that, from January 1, 2019, the use of the new National ID number – and not the BVN – will be mandatory.

[418] Communications Week (2014) *NIMC, CBN at Loggerheads over BVN Scheme*, available at https://bit.ly/2PIiunb

[419] Pierre Biscaye, Sarah Coney, Eugenia Ho, Brian Hutchinson, Mia Neidhardt (2015) *Review of National Identity Programs*, available at https://bit.ly/2EFgs6B

[420] New Telegraph (2018) *Only BVN data useful for national database –NIMC*, available at https://bit.ly/2CZh98X

Annex G: Regtech Use by the Nepal Rastra Bank (NRB)[421]

NRB, the Central Bank of Nepal, with the support on UNCDF and MM4P updated their reporting system to create an e-mapping platform based on a geographic information system (GIS).[422] They recently launched their 'Financial Inclusion Portal' which provides real-time information and data on financial access and usage.[423] The platform maps all financial points in Nepal, including but not limited to users of bank accounts, banks, bank branches, and branchless banking agents. The objective of this regtech solution is to promote financial inclusion.

The Banking and Financial Institutions Regulation Department in the NRB may be able to use the data from the platform to prioritize approval of new financial service points in regions where there are none.[424] Moreover, the platform also tracks the progress of the campaign that promotes at least one bank account for each household and encourages data-driven policy decisions.[425][426]

An app called 'NRB Data Collect' was also developed to automate data collection. The app allows FIs to upload their compliance data along with geo-spatial information of each service point (branches, ATMS, cash-in/cash-out points, money exchanges, bill payment merchant networks and remittance agents points).[427]

NRB is also currently in the nascent stages of developing a system that allows FIs to directly push raw data to NRB for the Bank Supervision Department. The single system is expected to replace email and mail submission of reports, collect all the data required by the NRB, distribute relevant data to the respective functions and analyze the data for supervisor's use.

Since there are no manual interventions when using this regtech solution, the data received by the Central Bank is expected to have less errors. It also relieves somewhat the burden on the FIs including DFSPs. The differences in IT of FIs, however, places challenges in the integration of the regtech throughout the industry. Many FIs may have to make changes to their current system to accommodate for the regtech.

Since banking products are increasingly becoming more integrated with mobile services, NRB needs to communicate with the telecommunications authority regarding the use of regtech for supervision. Even though there is already an MoU between the two regulators for technology security, an MoU on data sharing would be beneficial.

Annex H: Putative Needs Checklist for Regtech Development

What is the central bank trying to achieve?

As an omnibus general objective, the central bank may want to modernize its approach to its supervision capabilities. This may be fueled by the identification of gaps and inefficiencies in the current processes or even just the need to keep up with the rapid developments in technology.

What are the gaps and inefficiencies the central bank is trying to address?

The central bank may have specific needs, problems or challenges that require intervention and may be best addressed by a technological solution.

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[421] Based on conversation with NRB official

[422] UNCDF (2017) *Building A Backbone for The Financial Sector In Nepal*, available at https://bit.ly/2IP1l7P

[423] *See* www.emap.nrb.org.np

[424] *ibid.*

[425] Based on conversation with NRB official

[426] Government of Nepal (2015) *Budget Speech of Fiscal Year 2015/16*, available at https://goo.gl/Qxh6ww

[427] UNNATI (2017) *Mapping financial service points in Nepal*, available at https://goo.gl/pkDK1d

Where do these needs or gaps emanate from?
Internal: There may be an internal need, for example to harmonize the data collection formats, required data sets and reporting timeframes of the various central bank departments[428] and to automate data validation and analysis. This could be linked to the need to standardize central bank processes and also refocus human resources on analytical tasks rather than laborious manual tasks. Some AI applications may also assist the central bank in fulfilling a consumer protection mandate.

External (compliance): There may be a need to integrate the central bank's data collection systems through APIs with financial entities who have automated their compliance-related reporting to improve efficiency and accuracy.

External (regional): Central banks may need to integrate their reporting and AML tools with regional bodies and switches in order to be able to make more robust conclusions on suspicious activities.

What are the processes in the development?
A detailed description of the development phase can be found in **Section 3.3**. The phases can be summarized as:

- Identifying the need for technological intervention
- Planning the development process
- Procuring the development of regtech
- Developing the prototype
- Testing the prototype
- Implementation of regtech

Who is/needs be involved in the development?
The development process may involve external parties in each stage along with the central bank staff and TSPs (where applicable).[429] External parties such as consultants, donors, testers are usually involved in the process when central banks lack the knowledge and capacity to perform the required tasks on their own. If the regtech is externally focused, central banks may have to involve market participants to understand their pain points and current systems in order develop a regtech solution that can be also easily used by the market participants for purposes such as reporting compliance data. It could also include other regulators who may benefit from the solution, either through establishment of a shared regtech solution or knowledge sharing.

What are the constraints in the development?
It is important to identify the central bank's constraints so that they can be addressed during planning stages.[430] For example, the central banks will need expertise to undertake a needs-analysis as well as procurement and development of technology. However, central banks may not have staff with the knowledge and skill. It would require them to involve external parties. Moreover, in situations where funding is limited or fund deployment from government is slow, donor funds may also catalyze the process to minimize the barrier posed by high upfront costs.

How long will the development, implementation and adoption process take?
The development plan should include an estimate of the time required for each phase based on the insights from the scoping study and the complexity of each phase. It may take 6 months to identify the specific need and plan the procurement and development process, followed by 4 months to implement the procurement plan and select a TSP or gather resources for in-house development, and another 10 months for developing and testing prototypes. Based

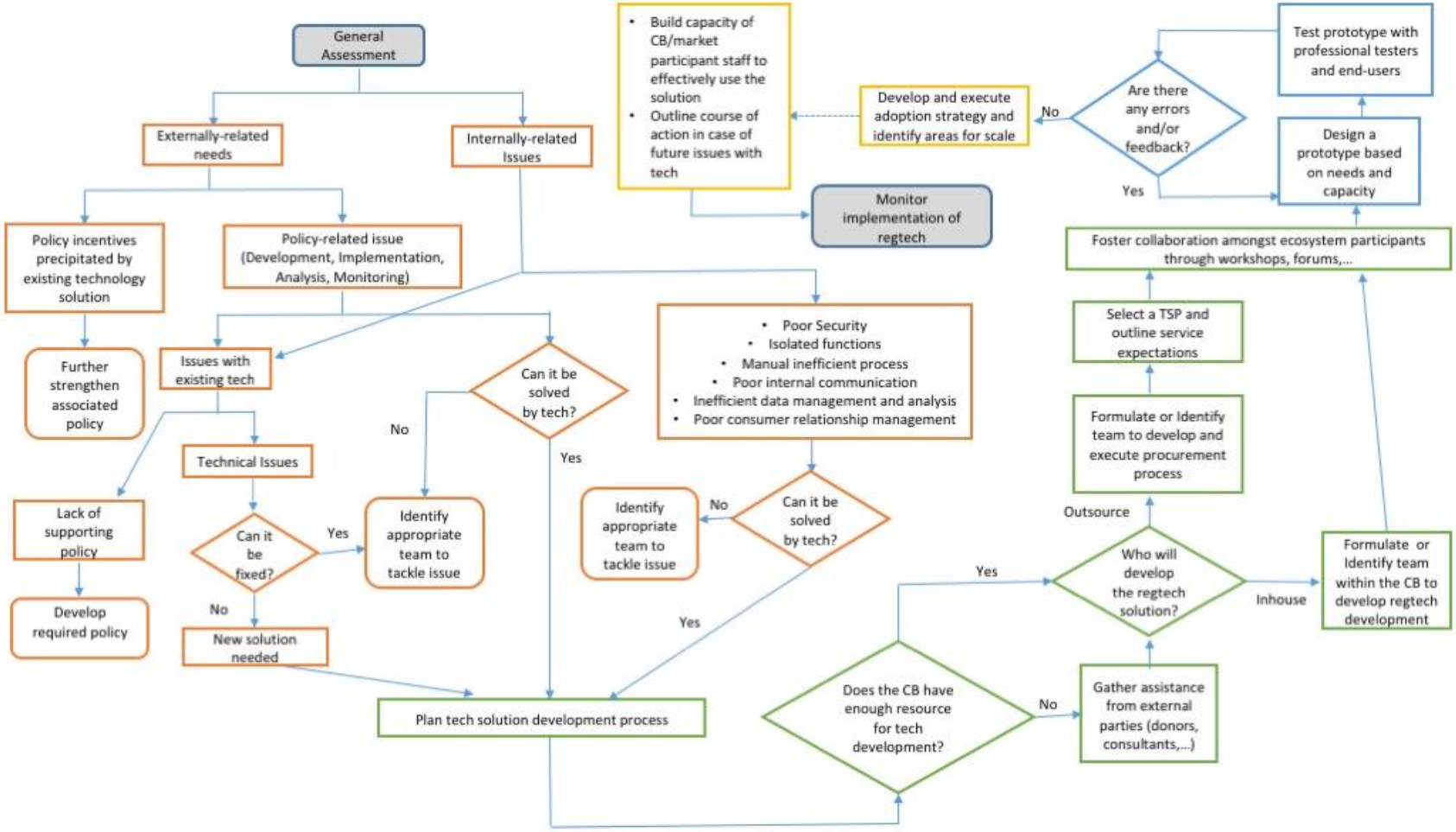
[428] For example, divisions dealing with banking, payments, oversight, central securities deposit, capital markets, or money laundering
[429] See Section 3.2: Primary Actors in Regtech Development
[430] See Section 6: Challenges with Regtech Development in Developing Countries

on the feedback, the estimate for developing the actual technology and implementing it across the board may change.

How will it operate?
To obtain the desired result from regtech use, central banks will need to ensure that each proper implementation and adoption of each components. If it involves the input from market participants, they may have to provide the market participants with the tools for easy and proper adoption. If it is internally focused, it may require the capacity building of the internal functions.

Who will operate it post development?
The central banks need to consider whether the technology will be completely handed off to the central bank or will be run by the TSPs along with the central bank, who will address any issues that may arise with the technology and who will use the outcomes of the technology. If many of the central banks manual tasks are automated and more focus is placed on analytical tasks, central banks may need more staff that can complement the regtech such as data scientists.

Annex I: Graphical Matrix of Regtech Development Process. The process is initiated by a general assessment to identify the specific needs of the regulator. The process can be loosely divided into 4 different sections: problem identification for regtech solution (orange), regtech development preparation including procurement (green), regtech development (blue) and regtech adoption and implementation (yellow).



Annex J: Reserve Bank of Zimbabwe National Payment System Reporting Template[431]

1.PAYNET TRANSACTIONS THAT HAVE SETTLED THROUGH THE RTGS BY BANK

Month ie	01/Month /20….	to		31/Month /20….	
	Payments		Receipts		Net Position
Institution	Volumes	Amount (USD)	Volumes	Amount (USD)	Inflows(OutFlows)
A					-
B					-
C					-
D					-
E					-
F					-
G					-
H					-
I					-
J					-
K					-
L					-
M					-
"ON US"			-	-	-
TOTAL	-	-	-	-	-

PAYNET | ATM & POS | Issuer Card Transactions | Mobile, Internet & Cash | Remmittances | Debit & Credit Orders | Reportable Events | Bank Information

7. Reportable Events

Please report any incidents of fraud which might have occurred with cards or mobile and the action which was taken.

Incident	DATE Occurred	Nature of fraud	ACTION TAKEN	DATE CLEARED

PAYNET | ATM & POS | Issuer Card Transactions | Mobile, Internet & Cash | Remmittances | Debit & Credit Orders | Reportable Events | Bank Information | Sheet1

431 Reserve Bank of Zimbabwe (2018) *National Payment System Reporting Templates*, available at http://tiny.cc/ke7c0y