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Digitalization, Emerging Technologies, and Financial Stability: Challenges and Opportunities for the Banking Industry

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Abstract

The article assesses the impact of digitization, ICT, and emerging technology tools and applications on financial stability. The article focuses on three principal areas inter alia, the disruptive effects of the entry of FinTechs and TELCOs into financial service provision; Application Programming Interface (API) platform open banking; and Block Chain Technology (BCT) based development and deployment of financial services. Digitization and ICT revolution have deepened financial development as new players in the form of FinTechs and technology companies have entered financial service provision, providing customers with an increase in product and service variety and ever declining cost due to competition between traditional financial service providers and nonconventional new entrants; enabled financial institution to adopt new business models that are leveraging on data collection, storage, sharing, and discerning actionable insights; accelerated and strengthened financial inclusion initiatives thanks to the ease of use, flexibility, affordability, and security of mobile technology; speedier and low cost; cross-selling other financial services the financial service offers ranging from mortgages, insurance, financial planning, investment management, which has contributed to higher educational attainment, financial literacy and human capital and that in turn have been associated with an inclusive growth, higher household incomes, leading to lower poverty and income inequality. Digitization and ICT, have also enabled financial institutions to develop and deploy API based Open banking services, which generate benefits that include a more diversified customer base, new collaboration possibilities with both banking and non-banking companies, enhanced ways to leverage customer experience of both existing and new ones, creation of new services; enhanced capacity and capability to meet an increased array of customer needs; enabling banks to reduce customer churn; and increase the share of banks in their customers' wallet through upselling and cross-selling of services. Moreover, through aggregation platforms that automatically standardize and normalize financial data, banks have an added advantage they can use to leverage data analytics tools to offer new service offers that complement the customer journey. That should sound good news for stronger bank health, which should also be vital for the bank sector and financial system health. BCT and benefits that are associated with enhanced cyber security, decentralized authentication, increased operational efficiency, low compliance cost, shorter onboarding rates of new product and services offers, a new set of product offers in the form of crypto assets[1] that should diversify asset portfolios, increase variety of revenue sources, hence resilience in the event of a slowdown in one or so bank's business lines. Trackability of transactions and assets in real time, around the clock, which coupled with the immutability of any activities that are authorized by network participants, are features that can add to an array of product offers, business processes, reinvigorating business models, hence good for financial stability.

Nonetheless, potential dangers from rising digitization to financial stability cannot be underestimated. The rise in the involvement of FinTechs and TELCOs in the delivery of financial services poses financial stability risks that are attributable to the reduction of interest-earning income sources for banks as FinTechs and TELCOs are leveraging their large customer databases to offer savings and lending services, peer to peer payments' services, and money transfer services; undermining the ability of banks to function as monetary policy transmission channel due to their declining importance in domestic credit creation, money supply transmission through holding third party deposits, buyers of government bonds, and reduced potency of the level of excess reserves general banks hold in central banks on liquidity in the financial system. Meanwhile, with respect to API, potential risks arise from an increase in partner and counterparty risk, technology incompatibility risks and attendant domino effects on other players in the financial system; fears of opening businesses to competitors; and uncertainty of long-term profitability of platform-based business models in the aftermath of breaking down the organization into smaller, coherent business units that are required in developing APIs and platforms. BCT-related risks to financial stability, are likely to arise from the rising vulnerability of BCT to hacking, theft, and data breaches rises concerns that, from critics of the secretive, decentralized distributed record-keeping, anonymous, low cost, double encryption hyped platform network-based transactions and are increasingly raising worst fears of financial institutions that are participants of falling foul of compliance requirements, creating costly sources of reputation risk, which depending on response and recovery efforts, may culminate in potential financial ruin, and by turn posing both direct and indirect danger to financial stability.

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I. Introduction

The last time I paid charges for my temporary stay visa in the local immigration office I had to wait for nearly half an hour as the individual managing the counter was perhaps trying to address some technicalities that had gone awry. However, doing the same exercise in 2019, was remarkably and starkly different in more ways than one. Upon submitting a complete list of application papers to the immigration official, who subsequently took some minutes to check that all was in order, I received a payment order note that directed to me toward an orange minibus that has been converted into a service spot, which she referred to as 'the bank'. I initially hesitated, due to the uncertainty as to whether it was not both my ears and eyes, more so the latter having been afflicted by serious myopia since birth, that were playing tricks on me. Prior to that event, I had only associated those vehicles that belong to the Indonesian post office, and are often parked along strategic points on sidewalks to serve as mobile post offices for customers to take their mails and packages to post office premises, obviously saving them the trouble of making the long distance to the brick and mortar office with its queues, parking charges and other inconveniences.

However, I eventually obliged and headed to the minibus, and my regret was that the few minutes I spent asking for confirmation, meant that I had already been beaten to the queue by two persons seeking the same service. Apparently, in a little over two years' time or so, the Indonesian post office had joined hands with some state banks, and the Ministry of legal and human rights affairs, obviously after receiving approval from the Indonesian financial services' supervisory authority, to serve as a payment transactions spot for visa services. While this new business line cannot be regarded as disruptive at the beginning, it has the potential to create a competitor for payment services that conventional banks offer in the long run. This will materialize as the Indonesian post office gains experience, which will not take long thanks to its long history in the logistics business. Not that the financial services industry has not taken some groundbreaking measures to join the fray Being a stringently regulated industry, the Indonesian government has to a large extent paved the pathway of digital transformation in the financial service industry, especially retail banking. However, it is not difficult to discern the continuation of the usual sitting on the fence by many players in the financial services industry as they observe developments in the digital transformation space to gauge opportunities, obstacles and challenges before taking the plunge. While such an attitude is normal and to many has been tried and proved as vital for success in the past, it is highly doubtable that such perspective and outlook will not lead to becoming perpetual laggards thanks to the rapid and constant changes in dynamics, rules, players, hence drivers of success in digital transformation.

One of the initiatives has been the*Laku pandai* program, under which Indonesian commercial banks have established branchless banking, which is specifically tailored toward offering financial services to underserved and underbanked sections of the population. Under the *Laku pandai* program, financial institutions are able to deliver services that include saving, lending and micro-insurance services through agents and other institutions, using easy and simpler ways than is the case with conventional financial services provision. Under the program, agents provide basic saving services through a saving account that does not have administration fees, no minimum balance and cash deposits, and limited frequency on withdrawal, but can only issue loans after obtaining approval from the bank under which they operate. The program is expected to involve 13 national banks and the recruitment of 350 000 agents per year (Amianti, March 27, 2015).

By March 2017, the number of*Laku Pandai* agents had reached 328, 466, which was a drastic increase of 51 percent from 160, 490 agents (2016), an even steeper increase of 164 percent from 60, 805 (2010) (OJK, 2017). The penetration of code-based payments is even more spectacular. Launched in August 17, 2019, by a collaboration between Bank Indonesia and the Indonesian Payments System Association, the quick response Indonesia Standard (QRIS), which is a mobile and web browser-based payments system that uses a QR code for all types of payments as long as merchants and service providers have registered their particulars with the managing agency. One of the advantages of QRIS is that it obviates the need to use different e-wallets to make digital payments. This implies that QRIS is linked to major e-wallets in Indonesia including OVO, GoPay, LinkAja, ShopeePay, DANA and WePay. More important, however, is that facilitates payments that are linked to commercial bank accounts, making it a game-changer. Bank Indonesia regulation No. 21/18/PADG/2019 mandates the use of QRIS for financial payment service providers that use QR in Indonesia. Commercial banks no longer have to develop separate e-wallets as a way to strengthen their customer engagement and experience, which not only reduces the need for outlay in that regard but also and most importantly, strengthens the leverage commercial banks have in digital payments space compared with their more agile and nimble competitors- fintech companies. As of November 11, 2022, QRIS is being used in 514 cities and districts, involves 127083 merchants including large, micro and small and medium-sized enterprises, and facilitated the IDR 382,027,768,637 in payments[2]. Bank Indonesia-Fast is another nationwide response to the growing need for a fast, secure, efficient and real-time, digital payments system that is available 24/7 to meet customer needs everywhere and anywhere. The development of BI-FAST, as Bank Indonesia emphasizes, is driven by several considerations including strengthening the domestic payments system toward creating an integrated end-to-end digital financial ecosystem; underpinned by the overarching goal of supporting the development and sustainability of an *integrated, interoperable,* and *interconnected* ecosystem that is crucial for the country's monetary, financial, and payments systems stability[3].

Using data analytics of customers, it has in its various business lines, either those that are directly under its control or those that it has access to thanks to its collaboration with external parties, the Indonesia post office has the potential to join the two Telecommunications companies (Indosat and Telkomsel) as a source of a very serious competitive threat to some of the key sources of non-interest income, especially remittances, money transfer, and payments management for commercial banks. It is a threat that is real, given the experience the Indonesian post office has garnered in logistics services. And the above developments are not limited to the Indonesian market but are in fact more pronounced in developed economies as Data released by Statista testifies. Projections in 2018 showed that of the 55 million people aged above 14 years in the US in 2018, 23.4 million would use Starbucks Application to make in-store transactions, 22 million would use Apple Pay, 11.1 million used Google Pay, and 9.9 million would use Samsung Pay (Richter, May 23, 2018).

Thus, there is no need to overstate the point that the increasing use of platform-based payment services is generating hefty revenues and income for the new nonconventional financial payments entrants, and obviously business, revenue and profit lost for credit card companies, traditional banks that underwrite credit card for customers, and credit card transactions processing companies. That underscores the extent to which knowledge and control over customer data and information has become the new Gold, with data analytics and information and telecommunications technology (ICT) being the fuel and engine, respectively, that is powering the big data transformation process. Moreover, the advent of the COVID-19 pandemic has not only created an unprecedented global peaceful time death toll, immense damage to core business capabilities, made orthodox business models obsolete if not irrelevant, and thrown skill and expert space into turmoil as some highly prized skillsets have become redundant as new ones assume prominence, but most importantly, it has had fundamental shifts in customer needs and customer journeys, increased the importance of having the capacity and agility to identify emerging opportunities and seizing them before competitors do, and changed the innovation landscape due to rising uncertainty about the realities of the next normal.

The implication is that there is a need to reorient and refocus innovation resources toward discovering actionable insights quickly and act upon them by making appropriate choices of production or delivery process technology; new product and service offers; business model reconfiguration in light of changing customer needs and attendant expected experiences, regulatory and competition dynamics; accelerate and scale new products and services to create first mover advantages; and an opportunity to make use of opportunities to collaborate with others in the same industry as well as different industries in the realm of backend and frontend operations technology, scarce resource mobilization, risk mitigation, and in establishing product and service regulatory standards. It is such a mindset and outlook that is expected to deliver growth during and in aftermath of the next normal economy (Am et al. 2020).

For the banking industry, the repercussions of the COVID-19 pandemic are sending shock waves across management boards as persisting anemic economic growth is contributing to an increase in risk-weighted assets, depreciation of liabilities and plummeting liquidity. Consequently, to meet prudential banking requirements, banks are forced to increase asset loss provisions, risk-weighted capital and liquidity buffers, while having to contend with declining revenues and profitability on core business activities and meeting soaring employee healthcare costs. Such a situation has created the need for a trade-off for low-income households between spending on basic healthcare services and other equally pressing consumption items, amidst increasingly uncertain incomes and rising risk premiums. Undoubtedly, the rising cost of living for households is compounded with an increase in economic and regulatory uncertainty, banking institutions don't have many options but to raise risk premiums on lending which coupled with an upward trend in the cost of funds, are sending financing costs upwards.

Doubtless, such conditions are undermining capital formation, lowering bank capital buffers, reducing bank liquidity, and if prolonged, pose the danger of accelerating the road to insolvency, which in turn will endanger current and future financial system stability. Nonetheless, crises have often spurred high innovation activity, and the current crisis, which the COVID-19 pandemic has imposed on 21st-century mankind is no exception. Banks have to wade through tough times as they refocus their core businesses by shedding off non-core business lines, identifying targets for

mergers or acquisition; measures needed to reduce the capital hemorrhage, eying potential partnerships with FinTechs to hasten technology adoption that is crucial if not pivotal for business process reengineering, and product and service innovations (Buehler et al. 2020); and reconfiguring of business processes to support agile innovation and management culture. In a word, the case for digitalization has never been clearer and inevitable for the banking industry.

However, there is a need to emphasize that the increasing importance of ICT and digitization, does not lie in the technology per se, but rather in the immense contribution it is making toward corporate and economic value from products and commodities in general and services and knowledge in particular. Knowledge capacity in its various forms has long been recognized as the most important asset a company, society or country has or may acquire. In line with that development, economists have long recognized the fallacy of injecting immense capital resources into societies with material conditions that lack complementary factors such as appropriate human resource skills, economic and social infrastructure, and pertinent mindset, among others.

That may explain why, the level of development of a country can be linked to the extent to which it invests in knowledge-creation activities such as investment in research and development, education, human resource development, and protection of intellectual property rights (World bank, 2006). And an increasingly important source of knowledge today is information and communications technology (ICT). ICT has become an important source of knowledge creation, dissemination, updating, transformation, invention and innovation generation. That is why leveraging information and communications technology to increase financial inclusion is today considered one of the vital pathways to poverty alleviation due to higher affordability, ease, and simplicity of access to financial services, associated with the falling cost of semi-conductors, LCDs, and ICT devices and gadgets, as well as the implementation of fair competition regimes in many developing and developed nations alike.

Besides, using ICT has been linked to improving the effectiveness of economic activities that proportionately benefit the poor more than other sections of society (pro-poor growth policies). This is manifested in supporting for pro-growth processes (capital deepening, labor utilization and productivity, network effect, multi-factor productivity); enhancing efficiencies (service delivery support structures, financial infrastructure, infrastructure, private sector development, rural livelihoods); complementing specific pro-poor growth theories (supporting SME entrepreneurs, micro-credit availability through social capital); contributing to direct enhancement of poor livelihoods(investment in local agricultural research, construction of rural roads that connect the poor to markets); and in addressing systemic pro-poor obstacles (natural vulnerabilities, corruption, lack of capacity).

Besides, ICT is expected to contribute to pro-poor growth through market expansion and development that translates into lower transaction costs; reducing household and community vulnerability risks to natural and manmade disasters, and health emergencies; empowerment through facilitating increased communication, mobility, energy and water that help to foster better access to health and education services for the poor; market expansion, access timely and accurate information on better prices to sell products, source of emergency warnings that contributes to lower risks from disasters, and increasing effectiveness of responses to health services (OECD, 2005). In any case, ICT access is found to benefit the very poor compared to those categorized as poor in East Africa with education attainment, and living in urban rather than rural areas, being determining factors (May et al. 2014); improved access to commodity and labor markets, governance, and knowledge and skills enhancement (Maema, 2014), revenue generation and poverty reduction among Tanzania SMEs (Mascarenhas, 2014), in crisis and emergency impact mitigation in Rwanda during 2007-2008 food crisis (Diga et al. 2014).

A steep drop in semi-conductor prices, major advances in storage capacities, rapid increase in processing speeds thanks to major breakthroughs in miniaturization, and increasingly widespread use of broadband internet, have increased the cost-effectiveness of employing ICT-based gadgets and networks in programs, projects and activities in an increasingly varied array of areas in private and public life. Unruh (2015) studies a case that shows the adoption of electronic money in South Africa to channel entitlement payments as well as withdraw cash using MasterCard cards in collaboration with the government and vendors. It is a concept that shows potential benefits for adoption in social benefit transfer programs that will cut down costs and increase safety, security, convenience and transactions for MasterCard Company in the long term.

Efforts to widen and deepen financial inclusion are underpinned by the increasing use of mobile phones and information technology platforms. The relevancy of such efforts lies in the fact that they are integral and complementary to government efforts to reduce poverty incidence and income inequality across regions and sections of its population. Moreover, increasing access to financial services to the poor, as well as micro-enterprises, is considered pivotal in diversifying the customer base of financial institutions, strengthening micro-enterprises, reducing the cost of transactions by increasing cashless transactions, widening bank income sources, widening the reach of monetary policy instruments, hence monetary policy effectiveness.

This paper examined the impact and implications of, advances in emerging technologies in general and Blockchain technology in particular on financial services delivery (banking) and financial system stability. The key contributions of the paper include underscoring the importance that the ICT revolution and digitization have played in deepening financial development and financial inclusion by enabling the entrance of new financial service providers, and an increase in product and service variety at falling prices. It has also compelled incumbent financial service providers to adopt new customer experience-oriented business models, open banking services, and direct banking that leverage collaboration with either Fintechs or TELCOs in backend technology in developing products and delivering services that are based on insights from data on unmet customer needs, pain points, purchasing experiences, individual and cohort values and preferences.

Doubtless, the key driver of the fundamental changes in ways financial and nonfinancial institutions are redefining and conducting businesses today lies in the transformational impact that the speed of advancement, adoption and deployment of emerging technologies. PWC identifies eight essential technologies that include “artificial intelligence (AI), augmented reality (AR), blockchain, drones, Internet of Things (IoT), robotics, 3D printing and virtual reality (VR)” that are driving, reconfiguring, expanding the redefinition of the capacity and reach of the boundaries of the world of work, corporate operations, and the seamless use of technologies to support livelihoods in society (PWC, 2022). The eight technologies are fostering convergencies that are driving reconfiguration of the use of technology which are manifested in “automated trust, immersive interfaces, extended reality, working autonomy, digital reflection and hyperconnected networks” (PWC, 2022, pg. 28). The focus of this paper is on ICT, digitalization, blockchain technology and open banking and crypto asset space and the impact on banking operations and financial system stability.

The immense opportunity that BCT promises for banks are also another key takeaway, as it offers them the chance to widen the reach of their service offers beyond national and regional boundaries to virtually the entire globe. It also has unlimited opportunities it offers in product development through collaboration, cost cutting on overheads by adopting a decentralized ledger system, exchange and transactions through immutable smart contracts, and conversion of bank assets into highly secure crypto assets that are secured by encrypted key pairs. BCT promises banks benefits that include enhanced cyber security, decentralized authentication, increased operational efficiency, low compliance cost, shorter onboarding rates of new product and services offers, a new set of product offers in the form of crypto assets that should diversify asset portfolios, increase variety of revenue sources, hence resilience in the event of a slowdown in one or so bank’s business lines. Trackability of transactions and assets in real time, around the clock, which coupled with the immutability of any activities that are authorized by network participants, are features that can add to the array of product offers, business processes, reinvigorating business models, hence good for financial stability. Dangers for banks from increasing digitization are by no means few, which if not well anticipated and countered by rising to the challenge, may send the banking industry as we have known it since 1472 to the relics of history.

Digitization, by making financial service delivery mass-produced, remotely customizable, and delivered service, has propelled TELCOs and FinTechs into the limelight of financial service

delivery. Thus, thanks to their technological advancements, ability to leverage data analytics capabilities to align financial services customization, thereby contributing significantly to accelerated financial inclusion in emerging and developing countries, failure to adopt a new financial regulation paradigm that treats TELCOS and FinTechs as with traditional financial institutions, have the potential to increase the influence and control they have over market share in developing and emerging economies. If such a scenario is realized, it is likely to create a formidable and growing threat to the core business of traditional financial institutions, long-term profitability, and by disrupting and upending financial intermediation and monetary policy transmission mechanisms, pose a serious risk to future financial stability (FSB, 2020). This paper navigates potential pathways to avert such a worst-case scenario.

The following section presents an examination of the impact of ICT on financial delivery, followed by section three that delves into BCT, crypto assets and implications for financial stability. Section four presents challenges that changing financial services landscape is posing for traditional banking, financial institutions in general and financial system stability. The last section draws conclusions to the article.

II. The Dawn of the digitalization age and financial service delivery

Technological advancement and falling cost of computing processing capacity, data storage, and connectivity speed, have fundamentally shaped and influenced business models, winning value propositions, and essentially, underpinned drivers of competition in many an industry, in the financial and non-financial sectors alike. And the pace will only become breakneck when 5G internet technology will become mainstream this year (2020). This is because, 5G internet promises large bandwidth, high speed, low latency rate, and 'bi-directional bandwidth shaping', which will enable it to support high-resolution video streaming experience, virtual reality and augmented reality, and make real-time data transmission and exchange across connected devices mainstream (IoT) such as remote surgeries, inspections and repair of complex machinery installations, and online gaming just a click away (Sims, June 08, 2018; Kelly, 2019). The digitization revolution has spurred the development and expansion of branchless banking services by traditional banks as a response to the emergence of alternative financial service providers that either establish new business lines to their core businesses through leveraging information and communications technology (TELCOs for instance) or new lean, agile financial technology startups going it alone initially but with time forging collaborations with incumbent financial service institutions. Most of the disruption is attributable to the advent of financial technology companies (FINTECHs). Financial technology according to Kagan (2019) refers to the application of "new technology to improve and automate the delivery and use of financial services", a process that "helps companies, business owners and consumers better manage their financial operations, processes, and lives by utilizing specialized software and algorithms that are used on computers and, increasingly, smartphones."

FINTECHs provide services that include alternative financing that involve offering financial services such as lending by institutions that do not fall into the category of traditional banks, for instance, peer-to-peer lending platforms; data analytics services, which entail the provision of solutions to firm problems through delivery of data insights based solutions; digital banks that deliver banking services entirely online without physical offices and branches; marketing and trading support services that entail markets or platforms that bridge or connect the supply of and demand for, financial services and firms that deliver support for trading activities through offering technological solutions; payments and remittances; roboadvisors and personal finance services which involve the provision of financial asset management advice through platforms based on personal risk-return profiles and demographics.

Nonetheless, financial technology tools are not limited to retail services but have become crucial to better, efficient, effective, responsive and fraud-free front and middle offices, and backend services (reinventing the financial service delivery business process). In that regard, FINTECHs are offering software solutions and Information technology (IT), referring to firms that provide software/application and information technology solutions to business process-related problems such as improving human resource management, enterprise resource planning services (ERP), supply chain management, and cloud computing and storage services (Franco et al. 2020:6).

Consequently, one of the sectors that has borne the brunt of transformative disruption attributable to digital transformation[4](Reddy & Reinartz, 2017), is the financial services industry in general, and the general banking services sector in particular. In 2014, McKinsey projected the number of digital banking customers to reach 1.7 billion by 2020, while statistics at the time showed that during the 2011-2013 period, the number of users of the internet and mobile banking channels in Asia and Pacific region increased by 35 percent, while branch use declined by 27 percent. During the same period, banking customers completed nearly 20 percent, about 25 percent, and 40 percent of key product purchases, pre-purchase, and post-purchase decisions, respectively, using mobile or Internet devices (Sengupta, Lam, & Desmet, 2014). ICT and digitalization have become increasingly unavoidable thanks to the advantages they have for the enterprise, inter alia, enhanced connectivity, automation (efficiency), data insights-based decision-making, and enhanced innovation capabilities.

To that end, it is not surprising that digitization and attendant digitalization[5] (digital technologies that shape customer relations, internal processes, and value propositions (Ritter & Pedersen, 2020; Brennen & Kreiss, 2016) has become increasingly important in efforts toward increasing customer experiences through various forms of personalization in accordance with demographics, risk tolerance, space, context (emergency or normal), and even emotional state. This is thanks largely to the adoption of financial technology in general and machine and deep learning in particular, specifically artificial intelligence in interaction with customers (front office), vetting customer transactions (middle office), and operations (back offices). As Business Insider notes, banks are projected to save US$447 billion through investment in AI technology in the front and middle bank offices through 2020-2023 (Digalaki, 2019). Banks were projected to save US$199 billion in costs thanks to investments in AI technology to enhance bank customer identification and authentication capabilities, and to deliver 24/7 conversational banking services through chatbots and voice assistants that help in handling transactions as well as provide insights into customer voice behavior to discern patterns that are used in providing timely and personalized services based on customer needs, mood state[6], and experience, which informs decisions on providing personalized, real-time and context aligned solutions (Smolaks, 2020)

Meanwhile, another US$217 billion in cost savings is projected for banks during the same period through the investment of AI technology in middle office processes to strengthen antifraud and risk detection processes including enhanced payments fraud detection and bolstering anti-money laundering processes and know-your-customer (KYC) regulatory checks, while banks are projected to save US$31 Billion in costs by investing in back office processes to reduce risk of financial products and services by for example strengthening loan covenants through smart contracts (Digalaki, 2019).

Nonetheless, digital technology is also making inroads in reducing financial exclusion by helping in providing solutions that increase access and affordability of financial services to 1.7 billion of the World's adult population (World Bank, 2018) that remains financially excluded from such services. Lack of access to financial services by 27 percent of the World's population implies that they face formidable hurdles in improving their quality of life through making use of "savings, credit and insurance, starting and expanding businesses, investing in education or health, managing risk, and weathering financial shocks[7]". One of the forms chosen as an effective way to increase access to financial services to deserving but still unserved sections of society is the establishment and expansion of no-frills financial services through branchless banking. Branchless banking does away with the need for potential customers to meet stringent requirements, which to this day have become stumbling blocks in the endeavors of many poor people to make use of financial services.

Four national banks (Bank Mandiri, state-owned and the largest domestic bank by assets, Bank BRI, a state-owned bank that is the leader in delivering small loans to millions of SMEs at market rates in Indonesia; Bank BCA, the largest private domestic bank and leader in transactions payments services delivery, and Bank Tabungan Pensiunan Nasional(BTPN), a bank that was established to manage pensions of civil servants, the police and army establishments, have secured operational licenses from the Financial services supervisory and regulatory agency (OJK), that allows them to establish branchless financial services through the code-named *Laku Pandai* (literary behave smartly) program. The program itself envisages recruiting individuals who will serve as agents for banks in delivering services that will include saving, insurance, and other services that partners of banks they represent provide.

Thus, internet and mobile banking have become an opportunity equalizer for sections of the population who have long been excluded from financial service delivery(Demirguc-Kunt et al., 2015). It is a trend that will continue if projections come to fruition. While 84 million Indonesians had access to the Internet in 2017, a figure that rose to 107.2 million in 2019, and is forecast to reach 150 million in 2023 (Statista, 2019). The extension of the internet network, coupled with the drastic decline in mobile phone prices, has for many financially excluded Indonesians brought the opportunity to enjoy regular financial sciences.

Moreover, access to mobile financial services also increases the capacity for businesses to expand and achieve better performance, especially those that are of small and medium size, which are often left out of coverage of formal financial institutions; facilitate investment in human development through education; increases propensity to responsible risk-taking, which is imperative for entrepreneurship, ground-breaking and game-changing innovations and inventions; increases productive investment and consumption, both of which contribute to economic growth; contributes to heightened self-esteem due to an improvement in the perception of the World for the better, which has been associated with happiness (Demirguc-Kunt et al., 2015). Indonesia like other developing countries has been the use of mobile phones rising as prices of mobile phones, air time and now data connections have dropped amid advances in Information and communications technology (ICT) and an increase in speed and bandwidth of communications networks.

Considering that a lot of effort has been made to increase the reach of financial services to sections of the population that deserve it but are still excluded, in what pundits and practitioners are referring to as financial inclusion initiatives. Financial inclusion is important for a number of reasons, including but not limited to, the vital role it plays in increasing access to financial services of hitherto financially excluded groups and sectors of the economy, hence considered important in reducing poverty and facilitating inclusive economic growth; has been found to achieve higher acceptability in areas and sections of the population who have little or no access to alternative financial services such as underprivileged areas and the poor (all countries at least 10 percent of adults have a mobile money account as well as where the percentage of adults reported having a mobile money account than an account in a conventional financial institution are found in Sub Saharan Africa. Moreover, data on financial inclusion, positive a positive association between credit disbursement to small and medium-sized enterprises (financial inclusion initiatives) and greater bank loan default rates as reflected in levels of non-performing loans (NPLs), and banks being an important player in financial systems of emerging and developing economies, such a development augurs well for greater financial stability (Morgan & Pontines, 2014).

The above findings also collaborated with previous research that found that widening the diversity of deposit holders reduces the susceptibility of banks to correlated bank runs, and by extension, lowers the likelihood and severity of banking and financial crises thanks in part to the predictable nature of the behavior of millions of small borrowers and lenders (Han & Melecky,2013; Hannig & Jansen, 2010). Lower risk to banking systems lies in the fact that such lenders show relative stability and a strong willingness to pay off their loans, prior to, during, and in the aftermath of financial crisis times. To that end, financial inclusion programs tailored to the 'lower bottom of financial markets' has generally low institutional risk to lenders owing to the small balances and transaction volumes hence do not pose a systemic risk to financial institutions and where reputation risk arises, which it is manageable based on existing prudential and consumer protection tools.

Meanwhile, internet users increased from 181 million (2018) to 191 million (2019) (Eloksari, November 11, 2020), rose to 213 million (2021), and is projected to reach 240 million in 2025 (Nurhayati-Wolff, August 1, 2021) (Figure 1).

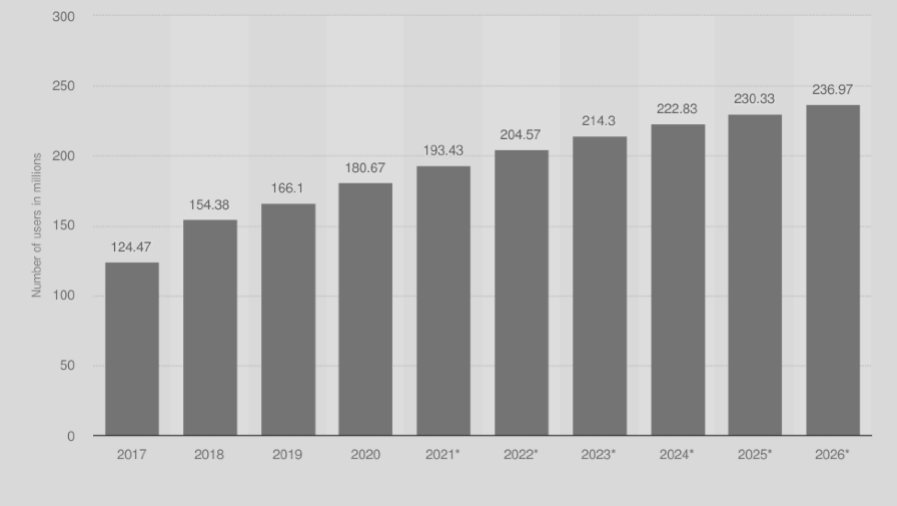

Figure 1. *Internet users current and projected in millions (Indonesia)*
Source: (Aug 16, 2021)

Such developments have led to the perception that mobile phones should serve as a medium of outreach in the various programs that target the underprovided sections of the population living in underdeveloped regions in the Country. This is more so in financial inclusion programs that are tailored toward onboarding sections of society that are excluded from financial services due to various factors that range from inadequate bankability; stringent requirements that many members of society located in remote areas with low physical and financial assets and limited education find onerous to meet; topography obstacles; and time constraints (opening and closing hours concurring with the time when people are involved in economic activities that earn them and members of their household livelihoods.

Besides, the significant decrease in data storage prices, increase in data storage capacities, advancements in communications and information technology (speed, capabilities, reach, and diversity), and rising importance of cloud web services, have led to a shift from analog to digital mobile services. It is such a development that has led to an increase in mobile phone subscriptions. Based on mobile phone subscription data, cellular mobile subscribers per 100 people increased from 2.4 (2002), 132 (2015), 164 (2017), but declined to 119 (2018) before recovering to 130 (2020) (Figure 2).

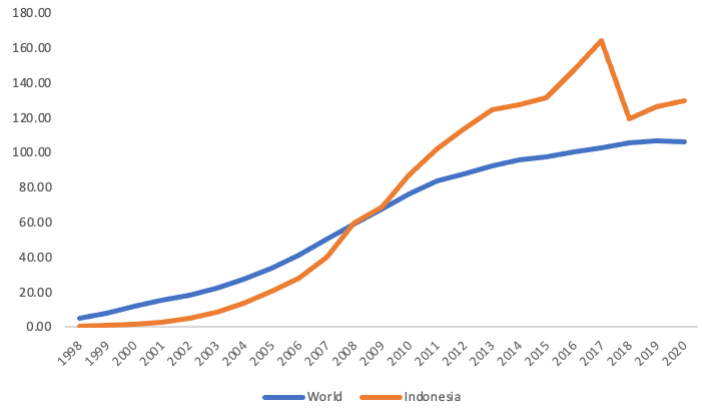

Figure 2. *Cellular subscriptions in Indonesia and World, 2020, compared.*
Source: World Development Indicators

The increase in cellular mobile usage (Figure 2), has meant that 131 million Indonesians had access to mobile phones in 2020 (World Bank, 2022). The increase in cellular phone ownership and internet access has underpinned an upward trend in the use of mobile phones as a medium to access financial services. By 2021, 45 percent of Indonesian aged 15 and above had mobile accounts, with the percentage of women higher than that of males, 66 percent and 23 percent, respectively (Figure 3).

Thus, as regards using mobile phones to access financial services, there is still a disconnect between high cellular phone ownership (73% of the adult population), internet access (51% of the adult population) and using mobile phones as a medium to access financial services (50% of all those who have mobile phone and access to the internet). It is only 26% of all adult working population (Figure 3) who have mobile phones and have internet access use them as a medium to store money.

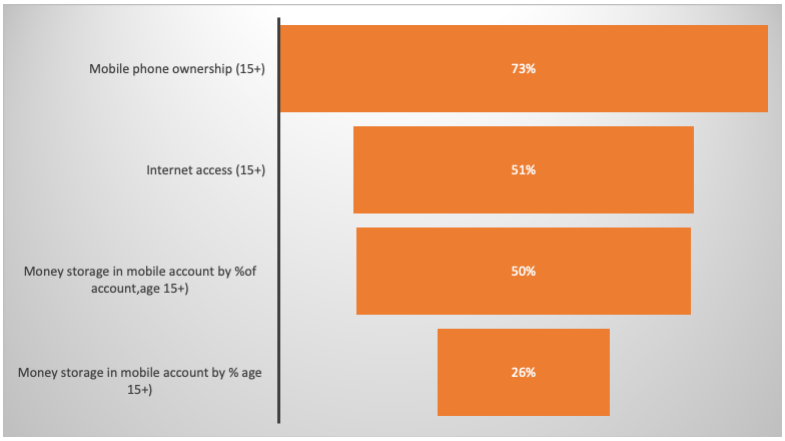

Figure 3. *Cellular ownership, internet access and mobile account ownership*
Source: Global Financial Index database (2022)

The disparity is also discernible from data on mobile phone ownership by social income status. While 56 percent of Indonesians aged 15 and above who hail from higher income group backgrounds have money accounts, only 28 percent of those from poor social income backgrounds do so. The gap is also wide based on gender. While 66.17% of the adult Indonesian female population have mobile money accounts, only 23.22% of their male counterparts do so (Figure 4).

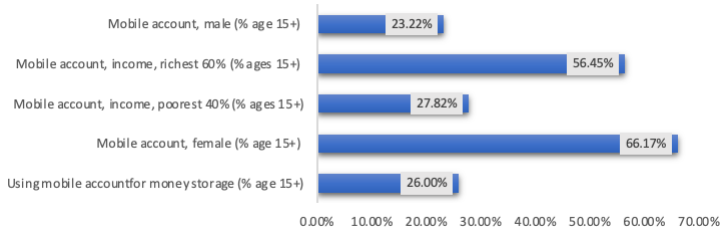

Figure 4. *Mobile account ownership by social income status and gender*
Source: Global Financial Index database (2022)

To that end, most people who own cellular phones and have access to the internet, continue to use them more for social networking purposes than as a medium to access financial services (Figure 5).

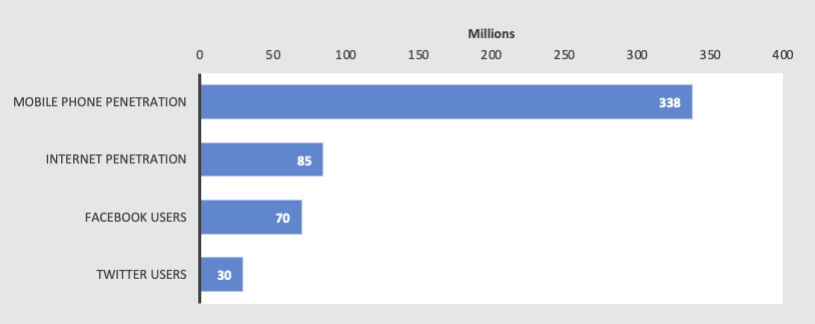

Figure 5. *Mobile penetration, Internet penetration, Internet penetration, and Social media usage*
Source: various sources

III. BCT, Crypto assets and financial stability

Despite its current nascent stage, blockchain technology (BCT), has the potential to contribute exponentially to global GDP, if projections are realized. According to IDBRT (2017) blockchain technology refers to "tamper-evident ledger shared within a network of entities, where the ledger holds a record of transactions between the entities underpinned by Cryptographic Hash Function." The huge but yet unexploited potential of blockchain technology will lie in the increase in efficiency of transactions in financial intermediation, healthcare provision, conducting elections, asset management, payment systems, law enforcement, trade and commerce, entertainment industry, social networking, and supply chain management (Figure 3). Efficiencies blockchain is generating arise from lower costs; reduction in intermediation costs as automation of initiating, conducting, approving, and recording transactions replace human labor; decentralized, replicative recording of transactions among all participants on the network, promise to lead to major cutbacks in firms cost in accounting and reporting fees paid annually to in-house accountant staff, and internal and external auditors; while security and finality of transactions make blockchain a reliable repository and exchange for transactions that involve a diversity of parties that are part to a transaction but have different yet complementary interests and located in various parts of the globe. It is no surprise that based on the World Economic Forum projection, by 2027 at the latest, if the current trajectory continues, 10 percent of the Global GDP will be stored on blockchain (WEF, 2015[8]).

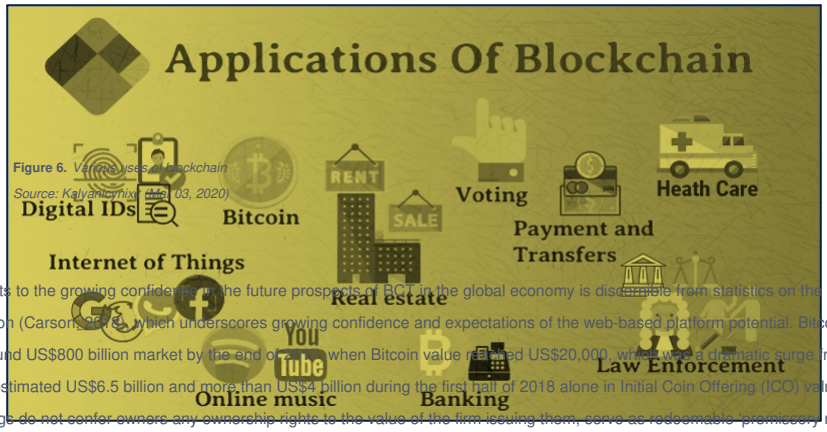

Figure 6. *Various uses of blockchain*
Source: Kalyanamix (Aug 03, 2020)

Besides, another indicator that points to the growing confidence in the future prospects of BCT in the global economy is discernible from statistics on the value of capital invested in blockchain startups in 2017 that reached US$ 1 billion (Carson, 2018), which underscores growing confidence and expectations of the web-based platform potential. Bitcoin value, which is one of the BCT-based applications[9], is estimated to hover around US$800 billion market by the end of 2018 when Bitcoin value reached US$20,000, which was a dramatic surge from US$20 billion in 2016 (Carson et al., 2018). In 2017, the world witnessed an estimated US$6.5 billion and more than US$4 billion during the first half of 2018 alone in Initial Coin Offering (ICO) value. ICO represents tokens that investors buy that while, unlike initial public offerings do not confer owners any ownership rights to the value of the firm issuing them, serve as redeemable 'promissory notes' in future in the event the underlying cryptocurrency comes into circulation.

In fact, ICO does not represent any valuation since they are based on a value proposition that may either or not ever materialize (Adriano, 2018:20). This is indeed borne out by the recent tumultuous decline in the value of Bitcoin and other cryptocurrencies, drastic decline in crypto exchanges as investors try to run for exit to avert even greater losses, which is contributing significantly to pushing down the value of nonfungible token assets (NFTs). Prior to that, however, the rising value of Bitcoin invited the interest of nefarious, treasure-hunting hackers and in some cases scammers. Hackers on several occasions targeted various crypto exchanges and ripped them off hefty crypto sums. Scammers, whose motives are to manipulate crypto-enthusiasts who expect to reap as much benefits without investing ample time, precaution in acquiring investment advice from pundits in crypto-asset valuation as well as making background checks on the veracity and integrity of individuals involved in establishing and administering cryptocurrency exchanges prior to digging into their pockets, from the very beginning target gullible investors to invest in roves after which they declare their concerns bankrupt, ostensibly, as was the case of MapleChange (Madore 29, 2018), which was a Canadian Bitcoin exchange, due to inability to pay investors anymore after a huge hack of their exchanges that cost them all the digital currency they had. Unsurprisingly, the above events sparked off a downward spiral in the value toward US$300 billion (having shed US$500 billion in the aftermath of the hacks and outages that created serious concerns about the purported security of the cryptocurrency against manipulation and theft (Chaparro, August 17, 2018).

Nonetheless, while Bitcoin and other cryptocurrencies (Srivastava, September 24, 2018)[10] have become increasingly circumspect for many in the aftermath of the cryptocurrency exchange hacks, confidence in the ability of BCT to become the reliable source of wealth creation (crypto assets), repository, firm value augmentation and scaling up, medium of transactions among various global participants located in far-flung parts of the globe, is growing. Many still consider BCT to have a lot of unexploited potentials. The rising trust in BCT, lies in several features that are appealing to entities and individuals that are wary of centralized control; opacity in the transaction process and contract pricing; centralized approval and recording of instances, and events (transactions); high vulnerability of online data to cyber-attacks; and high the potential for costly propriety data loss.

BCT has been designed to provide answers to such concerns as reflected in its outstanding features that include (Higginson et al. 2017) a decentralized ledger system that is based on an immutable and indelible storage of records (or instances of records to be exact) that are replicated in all blocks(nodes) that are connected from one to the other through chain code (blocks are recursively linked). The last feature makes distributed ledgers resilient to cyber-attacks, despite concerns that Mullen (2018) highlights; and instances or recorded once approved are devoid of manipulations, modifications or deletion (Henderson, Rogers, & Knoll. 2018; Crosby et al. 2015). Every digital event has its own specific digital footprint on the network with a date and time stamp when it is created that enables participants to recognize the owner or initiator; for a new digital event to be appended to the blockchain, it must be validated by consensus, which in a business network is entrusted to certain participants in accordance with their identities, encapsulated in digital certificates (which define properties of actors with respect to the organization they belong to, unit in the organization, role in the organization and specific identity, all of which influence access to resources on a blockchain[11]).

Distributed ledgers are either private or public. Private blockchain networks allow access only to certain participants or to use the blockchain protocol term permissioned (participating nodes for example Hyperledger DL[12]) on the networks, while public networks are accessible to anyone as they are permissionless (Bitcoin is a public DL). While Hyperledger is an open, flexible, and resilient source, the need to maintain high trust and confidence in the network, means that only participants (nodes) on the network can conduct transactions while network administrators or operators provide oversight. Thus, private blockchain networks, have some centralized control over who joins, do proof of work chores, and therefore contribute to the addition of new blockchains on the network. It thus implies maintaining some modicum of centralized administration and reduces the potential susceptibility of the network to nefarious activities including Sybil attacks, double spending, and permanent forking problems. Bitcoin, which is a virtual currency that is underpinned by a public BCT-based network, does not have regulators and allows anyone to open an account (node) which serves as a medium to conduct transactions (instances) on the network anonymously[13]. The increasing frequency of theft of cryptocurrency (or crypto assets as IMF prefers to call them (Andriano, 2018) from virtual currency exchanges may however raise fears that the level of cybersecurity even on those virtual networks may be susceptible to hacks, in the long term after all (John Mullen, June 21, 2018).

Indeed, past experience tells us that while in the short term and medium term, there are no firewalls that are free from hacking in the long-term, thanks largely to advances in hacking programming; complacency that builds up in legacy systems once such systems establish unprecedented breakthroughs in impenetrable firewalls at the time they are rolled out only to create the delusion that it is the last stage to the finish line in cybersecurity journey; stiff competition in computer programming various areas, including the realm of cybersecurity meaning that in order for any application to differentiate itself from the pack, it must first prove its potency and relevancy, which is achieved through identifying loopholes in existing systems, an incentive eventually that earns it a niche in the lucrative cybersecurity business; and advances in ICT and computer programming[14] mean that in the long term the development of applications that can hack into cybersecurity applications that were coded using earlier software programs steadily increases with time.

Thus, avoiding complacency requires striving to stay ahead of hackers by always strengthening and updating cybersecurity applications before any hacking incidents occur since once those occur may raise fears of a corpus of neglected loopholes that serve as good invitations for future hackers. Another important feature of distributed and decentralized ledgers, which contain transaction information in blocks (nodes) can be permissioned or permission-less, with the former meaning that participants must obtain permission from some administrator or operators in the case of a private business network) to make changes to ledgers while in the latter there is no need for such permission (the case of a public blockchain network such as blockchain) (The World Bank, 2017).

Equally important is the existence of double encryption that is equipped with public and private keys that allow participants on “the network to recognize now and in future, the “participant who owns an asset, initiated a transaction, or registered data in the blockchain.” Other network participants recognize the identity of each participant using the public key that is attached to the peer or block that contains instances of the ledger and instances of the smart contract. The blocks are linked together through end-to-end cryptographically empowered privacy services, which increases security, trust, and credibility of transactions (Crosby et al.2015). Another feature that has been lauded as having strong potential for business (Carson et al. 2018), is that BCT is not geographically and topographically constrained or bounded (geographically and topographically agnostic).

It is such features that have the potential to make blockchain, which is the technology that underlies cryptocurrencies, an effective and efficient anti-corruption technology, if the remaining hurdles that include the absence of common standards, consistent and coordinated rules are resolved. Blockchain, according to Higginson et al (2017), “is a shared, public ledger of records or transactions that is open to inspection by every participant but not subject to any form of central control.” In a more comprehensive definition or an apt description of the technology, Crosby et al. (2015) refer to blockchain as a “distributed database of records or public ledger of all transactions or digital events that have been executed and shared among participating parties. Each transaction in the public ledger is verified by the consensus of most of the participants in the system. And, once entered, information can never be erased.”

BCT-powered decentralized and distributed ledger system is efficient, saves cost, and equips participants with the opportunity to conduct and monitor developments in transactions that affect them in real-time, as all participants (nodes) have instances of records on the network depending on roles they play in a particular transaction. Replication of records along the network reduces the need for all participants on the network to keep records of the same transaction, and any changes that affect the transaction automatically induce changes in ledgers of participants who are party to the transaction almost instantaneously (diagram B). Distributed ledgers reduce the need for both internal and external auditing services since records in ledgers are automatically updated. In contrast, in traditional business transactions, every participant involved makes records of the same transaction separately, and updates take long to be incorporated into the record (as the process follows the closing of books cycle that occurs toward the end of a month, a quarter or the year), a process that is bedeviled by duplicity, inefficiency, high cost of keeping accounts and even more hefty spending on internal and external auditing services.

The technology has been hailed for having huge potential for application in financial services, utility management, healthy services, and I should add, dealing a death blow to financial fraud that is to come extent remains rampant in the industry. One of the advantages of BCT that is being put to commercial use is the digital record-tracking capability. Once a transaction is endorsed in BCT, it is immutable, and final. Such feature makes it valuable in maintaining the integrity of records of valuables such as copyright certificates, land titles, registration of asset exchanges as they occur, transaction payments as well as keeping track of illicit transactions such as piracy, fraud, health and welfare. By not being limited and constrained by geography and topography, BCT has been touted as vital in reducing the number of intermediaries and the cost of interregional and transboundary trade.

What must be noted as Carson (2018) clarifies is that a BCT can be configured in various ways that are in line with the requirements and objectives of a single use case, which strengthens resilience, and diversity of ways to extract value. Moreover, as a platform that facilitates smart contracts that are executed automatically by computer-predetermined conditions that are based on cryptographically encrypted algorithms that are therefore largely tamper-proof (Crosby et al.,2015). That may be the reason why some blockchain practitioners and scientists consider the decentralized ledger system, which is the underlying transaction recording system on blockchain networks, to be the starting point on the journey that will eventually culminate into the realization of autonomous management of companies with little if at all human intervention (Boucher, Nascimento & Kritikos, 2017). There is little doubt that given the problems that autonomous driving is facing, that prospect may be very far off into the distant future, but it will be here some time.

Besides, BCT has been described as inherently uncertain[15] but lauded for its high impact potential for financial services and the energy sector, due largely to the nascent nature of the technology that is still evolving, the trajectory of cybersecurity features of the technology, regulatory challenges it poses, whether the potential use cases translate into profitable business propositions, and most importantly, whether or not, the impact that is touted on the way transactions are arranged, recorded, verified turns out to be as conjectured (World Energy Council& PWC 2018; The World Bank, 2017).

Thus, BCT promises a lot of opportunities for banking institutions, that may reduce overheads they face thanks to the removal of the banking infrastructure that conducts transactions authenticity services as this function will be taken over by a public authentication system is affected along the entire network or the majority of nodes (based on nodes that consensus determined to vest with such authority), simultaneously and in real-time, making it devoid of manipulation and fraud (PWC, 2016). Such a system is inherently both efficient in terms of cost savings and time, hence enhances the capacity of institutions to conduct business in real-time. In the same way, the adoption of BCT should enable banks to reduce errors in key decision-making that are attributable to human factors through automation.

Moreover, if there is an element of blockchain that is winning the hearts and minds of regulators and banking practitioners alike, it is the super cybersecurity features the technology brings to the industry. The encryption mechanism in blockchain is underpinned by cryptography that in turn is based on a pair of keys, one is a public key and another a private key. Meanwhile, a public key is generated during the process of creating a transaction or event on the network and serves as the reference that other users use to identify the owner on the network. A public key, therefore, enables other users to verify the owner on the network. This is because of the relationship that exists between the public key (known to all network participants) and the private key (known only to the owner). The owner uses the private key to interact fully with ledgers and smart contracts in his or her block, and any transaction or message that is generated by the participant triggers a signature that is attached to it. Other participants on the network verify the source of the transaction by matching the public key associated with the participant and the signature attached to each transaction. This means that each transaction or message a participant communicates or sends out on the blockchain from a node has an attached signature which other participants relevant to the transaction or message can match with the respective participant’s public key to recognize its source on the network[16].

Another feature that enhances the security of blockchain is the way the public key and private key work. The public key serves as the identifier of the account owner among network users, hence known, while a private key, also referred to as the wallet, is only known to the account owner (in bitcoin it is 26 digits long) who can therefore use it to activate the public key to sign off on transactions on the Blockchain technology network. All network participants can use the public key to view their blocks as well as see records in blocks of other participants (since they know the public keys of others as well) but what they can see in other’s blocks largely depends on their designated access rights as determined in access control list (ACLs), which are embedded in characteristics that define the role they play in a certain transaction and consensus over the role they play on the blockchain network[17]. It is also important to note that a public key enables other participants on the BCT to encrypt messages designated for the respective owner of the public key, which the receiver can only on decrypt using his or her private key.

Nonetheless, having access to a public key does not allow another participant on the network to make transactions on another’s account since that requires using a private key. A private key is a 256-bit number expressed as a hexadecimal that contains cryptography generated randomly using a random number generator (RNG) or at pseudorandom using a pseudorandom number generator (PRNG) every time the user accesses the account and is stored on the local device (for instance cellphone or laptop). Moreover, unlike a password, there is no need to send the private key to a local

server for verification before activation to allow access, which reduces the possibility of being compromised along the way. The user must use the private key to It such a feature that makes blockchain 'unhackable' if all security measures are adhered to in blockchain design, deployment and administration. In other words, security is end to end, making it impossible to manipulate even by using brute force [18]. The downside of the private key is that since it is the only means the owner can have access to his or her Bitcoin, implies that in the event of loss, the owner loses the stash of Bitcoin in the wallet[19].

It also is noted that on commercial networks, which are permissioned or private networks[20], participants with both a pair of a private key and a public key can trigger changes in transactions on their account, to take effect or be recorded on the network, such transactions must be approved by participants who network participants vested with such authority on their behalf. Such a feature enhances trust in the network (Membership service providers, administrators, or operators).

In addition, all transactions that are recorded on the network are replicated nearly instantaneously along nodes of the network, which obviates duplication of the same records among different users, are indelible, immutable once endorsed hence adhere to the finality principle. That auger well for tracking the history of the record along the chain.

To that end, the adoption of BCT as a system should be advantageous for several reasons. Besides, reducing duplicity of the same records by participants that play different roles with respect to the transaction or event (service/asset owners, service/asset buyers, or asset transaction regulators), and though the transaction occurs along a network that has many participants, thanks to the existence of privacy services (public key, private key, and signatures) that link blocks along the network, the technology only allows access to network participants that are relevant to the transaction.

It is thus, evident that becoming a participant in a blockchain, reduces the need for a firm to invest in a costly database that stores transactions, as well as obviates the need for individual firms to manage the transactions (initiating, completing as they are automated and grounded in smart contracts), hence all such activities are relinquished to platform management, which being due to scaling advantages reduces cost members pay significantly[21].

Another important feature that has made blockchain technology popular, is the fact that network participants are involved in vetting members who are vested with the authority to endorse records or transactions, which upon endorsement cannot be modified, deleted, or inserted. The designation of participants with authority to approve transactions is based on the consensus of network members and included in access control lists (ACLs) that apply to participants and how they relate to transactions and under what conditions. That by itself underscores and enhances trust and confidence the system has among its participants. Blockchain has been hailed as a technology that will make the big four international auditing firms irrelevant, in the long run, if all projections of realization of its potential are realized. This is because BCT, upon deployment records all financial records that are created using various financial systems that occur in all regions and divisions of an organization in real-time; creates financial audits that are based on approved records, that once appended, cannot be tampered with; subsequently audits that have embedded security features are stored and can only be accessed by those vested with authority after certain security clearances.

It is not surprising therefore that BCT is regarded as a very important development in supply chain management. Given the stringent requirements that final users of products and services are demanding from final sellers and providers, the ability of BCT to keep a track record /history of a transaction from the start to the end enables producers to ensure that they deal with the right producers and suppliers which they can show as evidence and proof to regulators and final product and service users who may have doubts about compliance issues. Banks and other financial service providers, for instance, must ensure and are responsible for any improper use of their institutions that perpetrators of crime such as money laundering and fraud may do.

Thus, the ability of blockchain to track transactions right from initiators, intermediaries, to account owners in the bank (for a money deposit in a bank for example), enhances the capacity of banks to comply with anti-money laundering and fraud regulations, which in turn saves banks billions of US dollars in fines[22] they would have paid if found negligent, and obviously many billions more in damaged reputation (London, 2018; EU, May 2018; FSB, May 28, 2019; McLean, July 30, 2019[23]). Transactions (instances) on a blockchain must comply with the atomicity principle, that is transactions(instances) must meet all the predetermined rules that form part of smart contracts to be approved and recorded or failure to meet one of the rules leads to failure.

In other words, the atomicity principle serves as a tamper evidence and tamper resilience mechanism that makes instances on BCT-based networks extremely secure from unwarranted 'corruption' and manipulation. This is what is referred to as the smart contract system. Smart contracts underpin transactions that involve ledgers that are stored in every block or node along the blockchain, making possible automatic updates to values of assets along the blockchain for blocks of participants who are involved and relevant. Such a feature ensures not only automatic synchrony of the distributed ledger but keeps participants aware of how the state of the world of assets in their respective blocks and blocks of other members, depending on ACLs' designations of access along the network[24].

With the existence of consensus-based transactions and recording systems, BCT, besides reducing transaction costs, also removes many potential sources of disputes among participants (distrust due to transaction recording value, tampering with transactions, denial of involvement in a transaction, date when transaction occurs and so on). Such advantages have lured financial and non-financial companies to arrange transactions that have a high potential to enhance business value added for their shareholders. BCT has also been deployed in equity clearing on the Australian Securities Exchange, which is aimed at reducing the reconciliation back-office reconciliation work for member brokers; IBM and Maersk Line are developing a blockchain that will serve as a trade platform for "users and actors involved in global shipping transactions with a secure, real-time exchange of supply-chain data and paperwork" (Carson et al. 2018). JP Morgan (2016) considers blockchain to have immense potential in asset management in such areas as CDS processing and payment messaging, transaction management and regulatory reporting, custody and settlement of assets, replacing existing markets with private markets that are based on blockchain networks, issuing of digitized fiat currency, open, peer to peer blockchain-powered economy.

This in part may explain, JP Morgan's involvement in designing the prototype of the Project Ubin BCT network with the Monetary Authority of Singapore and Temasek, which is touted to provide commercial cross-border multi-currency transactions, serve as a foreign currency exchange and mechanism for settling foreign currency denominated securities (Geddie, 2020); and DLT ledgers, Singapore, which has so far facilitated US$3 billion in cross border financial transactions that involved 400 or so traders, more than 65 banks and tertiary partners[25]. Meanwhile, Deutsche Börse Group has somewhat similar projections with respect to potential use cases of BCT as a medium to foster cross-border collateral settlement of security assets, post-trade processing, including security settlement against cash and assets servicing, and the possibility of provision of commercial bank money (cash and assets) on the blockchain to facilitate payments settlement, and assets servicing (Deutsche Börse Group, 2016).

EY (2016) identifies prospects of blockchain technology in providing data management in the healthcare services sector are under serious preview. The uniformity of record authentication and credentialization makes blockchain technology appropriate for recording, maintaining, and sharing data on healthcare providers and patients at a high degree of accuracy and uniformity during the entire healthcare provision and claims management process. Features EY(2016) cites as efficiency and effectiveness enhancing in blockchain technology for provider data management in the health care sector include but are not limited to the immutability of records, the foundation for creating a unified provider ID, secure permissioning of health care provider data among service payers during the entire working span of the physician thanks to cryptography, possibility automation of internal control and request processes, efficiency from using a single infrastructure due to savings in labor, claims adjudication, reconciliation efforts, and improved member experience.

In yet another potential application of BCT, Singapore-based Points, which secured US$8 million initial funding from Danhua Capital, Cherubic Ventures, Ce Yuan, Ontology Foundation, and Nest. Bio Ventures and Zheng Cheng Xin Credit Technology, are planning to leverage BCT capabilities to build a credit risk score profiler algorithm that will be trained and tested on data that will be provided by the credit rating agency, Zheng Cheng Xin Credit Technology Ltd, which is also a partner in the arrangement, along with Tele info, Singapore city - a state-owned company owned, and Information technology(MIIT), will provide Points with 500 million data entries the startup will use to develop, train and test a credit an algorithm with the ability to develop credit risk score profiles (Caiden, July 23, 2018).

IBM, Deutsche Bank, HSBC, and Rabobank experimented successfully with the process of leveraging BCT in transboundary in a money remittance transaction that involved several countries in Europe. The pilot project involved Deutsche Bank, HSBC, Rabobank, and IBM, test piloted cross border money transfers that involved the four banks and Societe' General, and KBC across five continents using IBM *we. trade* platform that is based on an open-source, Hyperledger blockchain that falls under Linux Foundation.

The success of the experiment proved that BCT technology can generate efficiencies through using a common platform to conduct transactions, highlighted the BCT capacity to foster interoperability and connectivity and collaboration of participants within a trade ecosystem, showed the potential for even more gains to trade due to lower transaction costs, real time nature of transactions real transactions that allow trackability in real time, which creates additional value added to all participants (Canellis, 2018). The World Bank, as one of the leading development financiers that issue US$50-60 billion in bonds annually to finance various development programs in its 189 members countries, with the collaboration of the Commonwealth Bank of Australia (CBA) as the transaction arranger, made good use of knowledge and information it has obtained from its Blockchain Innovation Lab that was established in June 2017, to issue the first Blockchain technology-based bond valued at A$110 million (World Bank, August 23/24, 2018). Investors of the two-year maturity bond-*i* security[26] included CBA, First State Super, NSW Treasury Corporation, Northern Trust, QBE, SAFA, and Treasury Corporation of Victoria. This is a new development that will attract the interest of investors, investment management, funding agencies, academics and financial security practitioners, regulatory authorities, and the public.

Thus, there is little doubt, the above development being a potential pathway for diversifying sources of funds, investment, financial deepening and ultimately another channel to transmit monetary policy to both the financial sector and non-financial sector of the economy[27]. In another breakthrough in South East Asia, MoneyMatch, a Malaysian Central Bank-approved Fintech start-up, used RippleNet blockchain platform API, to assist retail users to convert Ringgits into Euros in transactions that involved money payment transfers to Spain, Germany, Latvia, and Ireland. The transactions were consummated expeditiously and at a much lower cost and time span compared to a standard money transfer transaction using the conventional SWIFT rail system (Blockchain News, October 17, 2018).

Based on International Data Corporation (IDC), spending on blockchain is projected to grow at a five-year compound rate of 81.2 percent during the 2016-2012 period. In 2018, blockchain spending is expected to reach US $2.1 Billion, will be more than double Worldwide total spending on the technology in 2017 (US$954 Billion), and will be US $9.7 billion in 2021. BCT today is estimated to s projected to reach US$3.1 trillion in business value-added by 2030. The potential the technology has for business is already bearing fruits. On January 22, 2018, a transaction that involved the shipment of Soybeans from the United States to China, with Dreyfus Louis Dreyfus Co, Shandong Bohi Industry Co, ING, Societe' Generale and ABN Amro as participants, using digitized sales contract, letter of credit and certificates on the Easy Trading Connect (ETC) blockchain platform was recorded as the first fully-fledged blockchain transaction (Reuters, January 22, 2018). It did not take long before another transaction, this time involving Hong Kong Shanghai Bank (HSBC). Meanwhile, on May 14, 2018, HSBC and ING serving as facilitators used the R3 consortium blockchain platform to arrange the shipment of US-incorporated Cargill's Soybean stocks from Argentina to Malaysia in what has been lauded as the first commercial trade finance transaction using BCT. Both transactions, according to participants generated transaction cost savings, transaction time, reduced needed paperwork, and enhanced transaction security (Green, May 14, 2018).

The overarching goal is for BCT to attract the World's 1.7 billion persons who remain on the fringes of financial service delivery to participate in the blockchain by submitting their data for credit risk scoring purposes, which in the end, banks will use as proof of creditworthiness to provide loans to them. Such a step should bring them into the financial services ambit. Doubtless, the success of the startup hinges on several factors, including its ability to develop an algorithm that can create credit credible profiles; participation of the unbanked in the project, which is the pivotal appeal of the value proposition; bank's willingness to shake off their fear of the default risk posed by the unbanked amidst the phasing in of the high operational leverage; and liquidity risk penalizing BASEL III banking regulatory and supervisory regime.

Other potential uses include Robo-asset management, automation of accounting and auditing functions; secure, immutable easily accessible and controllable digital identity that owners can use to do things that demand high trust and confidentiality (voting); using smart contracts in settling transactions that involve many parties but require trust, such real estates business(Andonni, 2018), registering, verifying compliance of employers with employee rights, securing property and possessions, tracking medicines to counter counterfeits, monitoring the veracity or genuineness of components of an Internet of Things to prevent nefarious acts from hijacking vital network system(during a remotely executed surgery involving many IoT components spanning long distances and using many internet connections provided by equally many providers); storing and transferring priceless records in fraud-proof, but immutable and easily accessible formats (patients private records, titles and certificates, wills, and music copyrights); and equity and futures trading (Williams, 2018).

And this a time when BCT is still in its infancy that is still plagued by a lack of a common standard that relates to transaction size, powers to entrust endorsement powers on the platforms, interoperability issues across platforms, and fears that rooted in closed networking systems that drew valued added from the secrecy of company data and information in vaults of silos that were only accessible by senior line and C-Suite managers.

Other worries relate to the possibility of a double spend scenario whereby some nefarious miners with an intension to discredit the blockchain do not disclose their poof of work to other nodes, leading to their adding blocks to their private network, until a time when such private network becomes longer than the original network, gaining what in Blockchain parlance, the accolade of truth. That means that based on blockchain protocol, the longer blockchain becomes the truth, causing loss and ruin to other nodes that are still using the original blockchain. The problem raises the possibility of regulators or totalitarian regimes, gaming small blockchain networks that allow miners to add new blocks at a very fast rate, which may go unnoticed by other nodes, enabling the rouge networks to seize the established BTC network once 51 percent of all blockchain nodes are under their control (Jimi, 2018; Tapscott & Tapscott, 2018). The possibility of that happening also raises another problem that BCT may not be as immutable as many experts claim, creating another veneer of uncertainty.

It is now time to turn to crypto assets -financial stability nexus. A crypto-asset, according to Tapscott and Tapscott(2018) is "a digital asset that uses cryptography, a peer-to-peer network, and a public ledger to regulate the creation of new units, to verify transactions, and to secure transactions without the role of middlemen," which is increasingly attracting the attention of private and public investors, individual and institutional, in part thanks to advances in the underlying BCT technologies, mainstreaming of protocols, and serious efforts toward standard convergence (that is enhancing interoperability[28] across Blockchains), increase in scalability (enhancing efficiency in conducting larger volumes of transactions[29]), and improvements in procedures and processes of verifying and creating new blocks on blockchains(forks).

Consequently, crypto-assets have become an invaluable potential investment class that is associated with the growing acceptance of the game-changing BCT networks, which is the technology that underlies such assets. BCT promises benefits that range from democratizing and deepening financial inclusion through easier access to initial coin offerings ICOs) for crowdfunded initiatives, BCT native commodities, to digital securities. Moreover, for banks, adopting BCT promises hefty benefits (safer storage of crypto assets, medium of conducting online transactions with other financial institutions and large clients, widening the reach of banking services beyond national jurisdictions, immutability of transactions hence lower chance of fraud, low cost of transaction due to decentralized but uniform recording of transactions, among others.

However, the recent plummet in the value of crypto assets including digital currencies[30] , hacks of exchanges, loss of access to e-wallets and the collapse of cryptocurrencies which has cost investors fortunes, underscores the danger that adopting and deploying crypto assets poses or individual, institutions and by extension, financial system stability. The risks associated with crypto assets are varied, including, the working of blockchain technology remains minimally understood for both investors and regulators alike so are the inherent risks; buying shares in companies with investments in funds and indices that have investments in crypto-related assets; and cryptocurrency mining, activity (Karnowsk, July 11, 2022); little compliance with governance and accountability; permissionless and pseudonymous nature of Blockchain makes identifying, recording, and linking identities of participants with transactions on the networks. Without such information, taxation authorities grope in the dark in trying to administer taxation, implying that BCT becomes a tax haven. Besides, touting the democratization of economic activities, the reality is that BCT networks are increasingly showing signs of replicating problems that are responsible for inefficiency and high transaction costs in traditional intermediated financial service provision-emergence of dominant players with leverage to exert power and influence over practices, processes, even access to and conduct of transactions on blockchain technology networks. Moreover, there is little coordination across various blockchain networks, which is a problem that in the long term is likely to have repercussions on traditional financial institutions and systems, if left unregulated (Makarov & Schoar, 2022).

Thus, despite the fact that intensive efforts are currently underway to plug the loopholes in existing regulations on financial innovations (BIS, 2022), the current regulatory and supervisory regimes for financial institutions including banking, have yet to establish common standards, processes, and regulations that can be used to mitigate risks that are associated with investing, financing, owning and trading crypto assets, especially those that are not banked by any other financial and nonfinancial assets, lack intrinsic value, and do not promise holders either real or contingent return (Banca D'Italia, June 28, 2022).

As regards banking, existing principles and protocols on prudential banking regulation and supervision issued by FSB do not explicitly tackle banking activities on BCT networks and in dealing in crypto assets simply because of the rapid pace at which the technology is evolving, which coupled with the apparent ambiguity of national and multinational regulatory authorities to decide whether to accept BCT and crypto assets as acceptable investment assets and one of the channels of doing business, and the reluctance of participants of BCT networks to reveal the level of involvement as that is antithetical to the existence of such network that is underpinned by decentralized, self-regulating hence low external regulatory oversight, and security of identities of participants and transactions.

Consequently as late as 2018, national banking regulatory authorities, and by extension, the Financial Stability Board did not yet have sufficient data on the level of bank involvement in crypto assets, making quantifying risk exposure and crafting risk mitigation programs difficult; regulatory authorities at the national and global level(FSB) have yet to establish standard categorization of both direct and indirect risk that is associated with participating on BCT networks and dealing in crypto assets (there is still a lot of grey area on what prudential measures regulatory authorities need to take, despite the slow but steady adoption of BCT in conducting transnational transactions involving merchandise and payments reported over 2018).

Regulatory authorities remain divided, with some considering BCT and cryptocurrency as an inevitable innovation that financial service will have to adopt due to the slew of advantages it has, while many, fear losing the control they have enjoyed for a long regulatory oversight, which coupled with bitter past lessons learned about the demerits of a decentralized self-regulatory regime with respect to financial stability (FSB, 2019). The jury is still out there, and we are still waiting. Hopefully, we won't be unfortunate to see a repeat of past financial innovations that proved too high-paced and sophisticated for regulatory authorities to regulate and supervise, which contributed to one of the major causes of the 2007-2008 global financial crisis.

Nonetheless, gradually the realization that the rise in popularity of crypto assets either directly or through counterparty transactions is bound to have risk implications for banks and by extension financial system stability. Crypto assets pose risks that arise from the fact that investors hold them for speculative purposes because essentially they lack intrinsic value; remain outside the ambit of regulation and supervision, hence conduct is not affected and influenced by the principle of "same activity, same risk, and same regulation", that underpin regulated financial activities (FSB, July 11, 2022). Potential risks from crypto assets, thus, include "liquidity risk; credit risk; market risk; operational risk (including fraud and cyber risks); money laundering and terrorist financing risk; and legal and reputation risks" from investments and financing transactions that involve crypto assets, which have necessitated the Basel committee for bank supervision to issue the second consultative report that includes proposals to proactively prevent and where occurrences become inevitable to mitigate future potential risk arising from crypto assets to banks and financial systems.

The Bank for International Settlement (BIS) in its June 2022 paper on crypto assets, has submitted proposals that envisage the implementation of measures to mitigate risks to banks from investments and liabilities that are related to crypto assets. Such measures include the classification of crypto assets based on whether or not they meet all classification conditions set out under the current regime; inclusion of the text that specifically tackles crypto assets exposures in the Basel supervision standards; refining and elaborating the classification conditions to take into account the revised classification of high-risk crypto assets that are not tokenized and lack stabilization mechanisms; an addition to infrastructure risk that introduces risk-weighted assets (RWA) to cover infrastructure risk for all Group 1 crypto assets. Other proposals related to recognition of hedging for certain high-risk crypto assets; delinking crypto assets from their classification as tangible or intangible assets under the accounting standards; revising operational risk clarifications to differentiate between risks covered under operational risk framework and those falling under credit and market risk frameworks; specification of the application of the liquidity risk requirements and treatment of bank exposure to crypto liabilities; introduction of a high-risk crypto assets exposure limit for banks of 1% of Tier 1 capital (BIS, 2022).

FSB on its part is intensifying efforts to coordinate national authorities and standard-setting organizations to reach a common understanding on diverse crypto assets risks sources, which is requisite for strengthening existing regulations and standards, and where deemed necessary to create new ones that will be specifically tailored to tackle the unique risks crypto assets pose to investors and financial systems whilst allowing investors and the financial system to derive the benefits of the underlying technology (FSB, July 11, 2022).

Thus, while BCT has hefty promises and prospects for corporate, governments and society, it has its downside. While it promises many uses, it is still plagued by some challenges that include, the absence of robust, universally acceptable standards due to the existence of various competing standards; and the likelihood of loss of crypto assets or limited or restricted accessibility thereof, in the event of a double spend problem or loss of private keys. It is also worth noting that BCT at least the permissionless version, upholds principles of decentralized management and control as well as the anonymity of participants. It is such aspects that complicate efforts to exact some regulation of both actors and activities as identifying and linking actors to activities, which is crucial for designing an effective regulatory and supervisory regime, is not a mean feat. It is a point that (Narain & Moretti (2022) highlight as one of the key obstacles to regulating crypto asset activities.

However, the major challenge lies in the varying perspectives and approaches central banks in both developing and developed countries have taken toward blockchain technology and crypto assets, especially cryptocurrencies. There is still no common ground let alone a standard approach or policy toward crypto assets including digital currencies. There is no better illustration of that than approaches made by various central banks toward central bank digital currencies (CBDC[31]). Based on the IMF's latest update on countries at different stages of CEBDC development and adoption, 100 national central banks are at various stages of launch, proof of concept, and research (Figure 7).

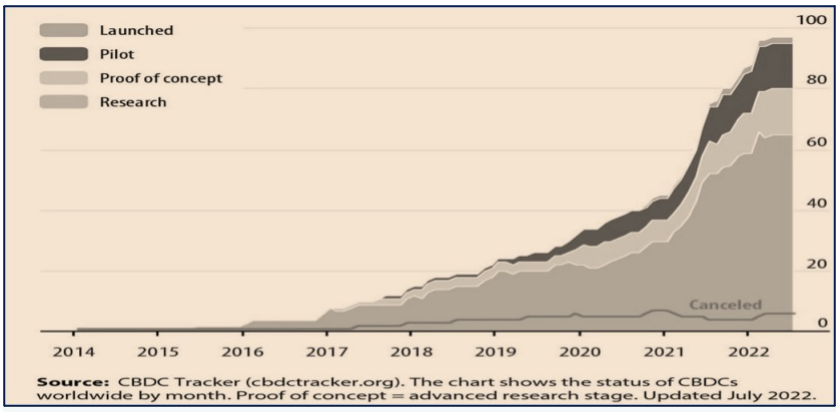

Figure 7. *CBDC stages of development and adoption July 2022*

Source: IMF(2022).

The Bahamas, Eastern Caribbean, Jamaica and Nigeria have launched retail CBDC, while Senegal and Tunisia and a host of 50 or so countries have opted to allow some forms of digital currencies to be issued by parastatals and private companies. Meanwhile, other countries are at various stages of CBDC piloting (29 jurisdictions), while 72 central banks have expressed a positive stance in their latest communication about CBDC (Decambre, 2019; Kiff, 2019; Auer et al., 2022; IMF, 2022).

Perhaps even more problematic is that today, the management and control over crypto assets, including cryptocurrency, remains largely if not fully, in the hands of the private sector, simply because blockchains on which such assets are initiated, recorded, stored, and exchanged are on either public blockchains or private ones, which are not regulated let alone under the supervision of monetary authorities. And the situation will remain that way if the latest developments are anything to go by. Facebook announced plans to launch its Libra, a secure permissioned blockchain payment system[32] that will use a digital currency as a medium of exchange represented by tokens that in turn will be backed by the value of hard assets. Libra is touted to have the huge potential to increase financial inclusion for millions of people who have either no or limited, access to financial services in the developing world.

However, the problem is that with rising volumes of cryptocurrency being created over time, the stakes will become higher for monetary authorities due to the potential danger that in the event of a double spend problem that leads to the erosion of cryptocurrency, may have disastrous repercussions on the financial system and economy (Tapscott & Tapscott, 2016). In any case, the onset of populist regimes that seek to maximize trade benefits for each participating nation (Trump's America being a good example), the global financial service architecture and governance which is based on the belief that high interdependency of merchandise and financial transactions which has emerged as one of the consequences of decades of globalization calls for all signatories for the sake of promoting collective and collaborative security and stability to comply with their commitments even under conditions that may not directly deliver benefits to countries they represent, face uncharted, risk-prone, waters that are akin to beggar- thy-neighbor policies that marked the tumultuous pre-Bretton Woods global financial system.

IV. API-driven Open banking and financial stability

Application programming interface (API)[33] , is the technical medium that enables developers to access data and services the platforms provide through a protocol to deploy applications that execute on a server elsewhere[34], or in the case of level three platforms, foster the use of programming language, data and services the platform provides and fosters code and functionality customization in line with third-party developer needs, imagination and creativity (Andreesen, 2007). APIs are gateways to platforms and in turn, access to data, services, and backend IT systems. APIs, thus, foster interactions among systems, code modules, applications and backend IT systems of platform providers, hence, enhancing data and code exchange internally, as well as externally. Such an environment creates immense opportunities for innovative products and services developed through collaboration across functional teams, and business units within the organization on one hand, and the organization with external parties, on the other. APIs are also credited for enhancing firm data lake exposure to data from disparate systems that fosters gleaning and integration of vital insights that support quick and flexible design, development and deployment of new applications, simplify product and service development of end-to-end solutions based on a modular architecture, by facilitating data usage policies, control, access, and performance measurement, leveraging of existing data interfaces in product and application development saving on invaluable time and resources, allow the development of data platform buffers in the form of centralized data lakes or decentralized best of fit platforms that handle transactions outside organization's core systems based on specific data usage and workloads of data users, reducing workloads on organization systems (Castro et al., 2020).

Organizations are increasingly using APIs to strengthen their value propositions to customers in a bid to increase customer experience with products and services they offer by leveraging internal resources, as well as collaborating with third parties to reduce gaps in customer journeys that nimble startups are exploiting to disrupt traditional value chains. Internet and web service developments have in part played an important part in that. This is because the increase in the use of the web as the principal network that integrates systems in the organization has compelled companies to adopt APIs to connect technology assets to online portals and mobile applications.

Moreover, adopting the API business model is not only confined to small, lean, startup companies, but also large firms. Large companies can 'decompose or deconstruct' their businesses into platform business models by "breaking up (the large company into) into smaller discrete pieces with clearly defined interfaces for interaction", based on three principles Baldwin and Clark

recommends for a good decomposed network, inter alia, i)an explicit architecture design that specifies the various sub-systems and their function; ii) a definition of interfaces that describe how the sub-systems interact with each other, and; iii) a set of standards that lay out the ground rules for the overall system[35].

Specifically, for banks, they can both publish their APIs to allow partner companies to access their back-end data and technology assets and use external APIs to strengthen their value propositions or create new services that are possible thanks to sharing of firm data and proprietary assets with other firms. Doing that creates an ecosystem that connects various units of the company on one hand, and the company with other companies, customers, supplies, and application developers. This is what some pundits in banking, Grinberg being one of them, call the Open banking regime.

Open banking, according to Gartner, refers to the delivery of financial services to users by leveraging API platforms, app stores, and apps (Moyer, 2013). In general, Open banking is based on the notion that data belongs to the customer, who therefore has the right to decide who he or she allows access to them, and otherwise (FDATA, 2019; Gałkowski & Podgajny, 2019). Moreover, the decision to share data can be reversed by the customer depending on whether preferences are served or otherwise. Data sharing in open banking regime attempts to prevent access to financial data taking the form of customer data, transactions data that involve the customer, and valued added data by other parties in ways that may be detrimental to the interests of the customer. Some of the benefits associated with open data regime include strengthening customer choice and protection from abuse of personal data, transactions data, and valued added data; by leveraging access to financial data at a granular level (customer and respective transactions), producers and sellers of products have the ability to use insights they glean from customer spending patterns, pain points, composition of products and trajectory of spending patterns to create personalized innovative products that enhance customer experiences, higher customer satisfaction and customer wellbeing; higher customer loyalty hence low churn, which translated into higher revenues and profitability; enhance the ability of banks to leverage their position as the institution in which most adult customers place their trust, to create financial services that are based on insights scoured from data at lower cost and limited reputation risk (FDATA, 2019).

To that end, many companies are becoming API publishers, which involves exposing their back-end data and technology assets to “internal, partner or third-party developers of client applications”, creating learning interfaces for API publishers (including banks) due to access to insights gained from data and technology external applications; collaboration in developing products and services with external parties to enhance the comprehensiveness of offers to customers, increasing cross-selling and upselling opportunities in the process. This is indeed one of the elements of adopting an offensive platform business model. Indeed, adopting a platform-based model achieves the most rewards for those companies that develop platforms that redefine value propositions for customers by strengthening customer experience, through better product and service offers, more detailed information of product information that enriches user experiences, and social content (Bughin & van Zeebroeck, 2017), including where possible collaborating with external parties. Benefits of an offensive platform business model (15% of 2100 companies surveyed) are substantial, as attested by achieving higher financial performance on the order of 6-7% in earnings before interest and taxes (EBIT) than those that adopted a defensive platform business model; and higher financial performance of companies than non-adopters (Bughin & van Zeebroeck, 2017).

Thus, the integration of external APIs has been touted with the potential to enable banks to access new customers, thanks to the creation of additional value added that strengthens services provided, while publishing APIs creates data sharing opportunities with other companies both banking and non-banking alike, which can be leveraged to increase customer experience of both existing and new ones, creation of new services, enhanced capacity and capability to meet an increased array of customer needs; enable banks to reduce customer churn, and increase the share of banks in their customers’ wallet through upselling and cross-selling of services.

Banks, however, can derive even more benefits from open banking by developing their own APIs, which third-party users including FinTechs can tap with the collaboration of API platform providers to deliver financial services. That way banks have the opportunity to benefit from the experiences of FinTechs with respect to agile product and service development and deployment, turn FinTechs from competitors into customers, getting access to data from third-party partners, which may help shorten the bank’s Open Banking learning curve as well as create a new source of revenue for the bank based on strategic assessment, analysis and mapping of third party on-demand BaaS needs (Nonninger, 2019). It is not therefore surprising that with the support of vendors, banks are implementing account API aggregation platforms that automatically standardize and normalize financial data, making them compatible with data formats developers use to develop financial applications, as well as data augmentation, through transaction categorization that makes a more valuable source of revenue that can be sold for a fee (for instance data on transactions can be broken down into product bought, frequency of purchase, credit history, place of residence, socioeconomic status and so on), or a vital source of insights for if subjected to data analytics tools for upselling and cross-selling and new service offers that complement the customer journey. Moreover, using the services of account API platform aggregators has another advantage, which is lightening the burden banks face in maintaining API connectivity with other institutions (Grinberg, 2017).

That said, it is worth noting that an open banking regime also opens vast opportunities for financial technology companies, which lacking legacy infrastructure that constrains their forays into new areas, have the ability to use financial data to create financial services at an even lower cost and short lead times that conventional financial institutions (banks specifically). In light of that, Open banking regime may pose a serious risk for traditional banks and other financial institutions, if they do not take advantage of its potential benefits as long as they still enjoy high public trust customers surveyed in Poland for instance indicated that they trust banks more (41%) than technology companies(Google (38%) or Facebook (22%), which allows them privileged access to use customer tagged financial data, to create a variety of innovative products at lower prices that enhance the holistic customer experience (Gałkowski & Podgajny, 2019).

One of the potential risks for inaction or playing the waiting game, for traditional financial services was revealed in Gałkowski & Podgajny (2019) report on the impact of the second payments services directive PSD2(EU) on Polish and European union banks. The report showed that while the results of the survey indicated that customers highly trust banks compared with technology companies, such trust depends on the age group of those surveyed. The willingness to trust technology companies (the key competitors of banks for customer data), increases with lower age brackets. Customers in the 18-28 age bracket have a high willingness to trust their transactional data to technology companies than those who are older. The implication is that public trust in technology companies is likely to increase with time as those customers who are young become mainstream customers (Gałkowski & Podgajny, 2019:7). There is little doubt that such findings may resonate with the general perception of customers in both developed and developing economies.

Nonetheless, fear of the unknown especially partner and counterparty risk, and technology incompatibility, still dents the interest of many companies that otherwise recognize the potential benefits of adopting such a business model. In a McKinsey (2017) study of more than 2100 companies, Jacques Bughin and Nicolas van Zeebroeck found that while most large companies were reluctant to adopt an API platform-driven based model achieved higher financial performance than those that didn’t. Reasons behind the strong reluctance included technology legacy problems that complicate platform development (API business model assumes systems integration, interoperability, connectedness, and data sharing across functions and business units, which is in contrast to a traditional business model that espouses separability of systems, data, even technology across functions, divisions or business units of the same organization); fears of opening businesses to competitors; the complexity of services outsources from third parties (Levy, While & Helbekkmo, 2019); and uncertainty of long term profitability of platform-based business models in the aftermath of breaking down the organization into smaller, coherent business units that are required in developing APIs and platforms.

Nonetheless, traditional banks face another even more formidable existential threat which takes the form of lean, online and mobile banking startups. Thus, traditional banks that are persisting

with the old banking business model, perhaps forced into inaction by legacy technology, functional, managerial, strategic and infrastructure problems, status quo indecisiveness and fear of the unknown, or indulging in wishful thinking the startup activity like the dotcom bubble will come to pass, and will therefore leave the financial sector fundamentally intact, are likely to face a reckoning sooner than later. The new challenge comes in the form of a lean digital bank. The new banking business model is based on deftness to meet the needs of the customers at a fraction of the cost conventional banks charge, with a lot more flexibility with respect to time, location, product features, and uniqueness of customer experience of financial products offered. There is no better example in this regard than Nubank, which is a US$10 billion banking start-up founded in Brazil in 2013, uses a lean banking model that leverages digital technology to deliver banking services that include as Savchuk (2019) notes “no fee credit card at below-market interest rates, customer services via mobile phones… easy access to customer service via chat, email, or phone; canceling a lost credit, ask for credit limit increase, or notify Nubank of planned travel through an app.” Nubank has 14 million customers and is rated as one of the most valuable startups in Latin America (Savchuk, October 22, 2019).

V. Major Challenges

There are not many banks, large and small, that have not recognized the strategic importance of developing winning financial inclusion strategies. Recognizing the important role that financial inclusion in general and using digitization as a pathway is another determining, let alone implementing the right strategy that suits the bank is another formidable challenge. One of the key obstacles is the possibility of resistance from within the organization from functions and divisions that consider financial inclusion initiatives that make use of digitization as a threat to their influence in the organization, especially with respect to control over resources. This is because digitization, by its nature, tends to enhance the pre-eminence of the information and technology division in the organization, as it is the function, research and development, marketing, finance and accounting, and human resources that play a pivotal role in determining the technology that is feasible for the organization in accordance with its core competencies and strategy. Involving all functions in the formulation, development and deploying of digitization-driven financial inclusion initiatives is one way to prevent the problem from affecting the initiatives, identifying champions for change in all functions of the organization is another. However, the strategy requires bringing the C-suite on board with the initiatives as it provides the galvanizing force for the organization and resources needed to support the fundamental change that is needed.

Worth noting as well is the fact that data collection, aggregation, storage, processing and analysis lie at the center of digitization. What makes the ecosystem services-based business model extremely invaluable and strategic for companies in financial and non-financial sectors alike, is the increased access it provides to a wealth of data on customer demographics, purchasing behavior, similarities with and differences from cohorts, and purchase history that firms can mine for insights on drivers of past behavior to predict future scenarios. The value of collaborations, partnerships, and procurement arrangements to businesses are today being evaluated based on the potential contribution they will make toward generating data and information from customers, suppliers and partners alike, that can be mined using advanced data analytics methods to produce actionable insights that serve business strategic interests.

To that end, the risk of entering into working relationships with third parties is the potential threat to invaluable core business data, inter alia, contents and structure of arrangements and agreements between the firm and third party suppliers, proprietary information such as intangible firm assets, customer data, operational and performance dynamics, and an invaluable set of customer data by data of acquisition, churning rate, retention policies, and data systems architecture and technology. In light of that, data privacy concerns as important as these may be today in the aftermath of Facebook[36] and Cambridge Analytica data scandal that involves the misuse of personal data for 80 million Facebook users, the implementation of the game-changing general data protection directive (GDPR) EU council /EU Parliament Regulation No. 2016/679 on May 25, 2018[37], and a release of a report by Digital Content Next that meticulously reveals the 24/7 ubiquitous nature and scale of Google data collection and collation practices without ever requesting permission from users that run the gamut from Google Chrome browser, Android operating system, Google search engine, Google Play, Google Gmail, Google AdWords, Google Maps Google, to Google Analytics (Kelly, August 21, 2018), are surprisingly not the only data security related problems that a switch and transitioning from an analog based to digitized services and operations, face.

Equally important is the increased risk of creating Frankenstein monsters that may in the long term pose an existential threat to banks. Collaboration with FinTechs by conventional banks may reduce the need for the latter to invest huge capital into untested financial service delivery models, the former may end up not only cutting into core banking services but eventually both core and non-core services. By gradually nibbling away at its core business bit by bit, what begins as a vibrant, highly competitive and dominant bank in its market, becomes a shell of its former self that delivers just a small, and an unprofitable portion of a lucrative financial service value chain at that, the succulent part having been nixed away by big tech companies, former plant suppliers, and a plethora of lean and agile FinTechs. That is an invitation for high bank liquidity variations, and ultimately bank solvency, and financial stability woes.

The latest development that relates to Canadian largest cryptocurrency exchange Quadriga, which is facing liquidity problems that arose from the sudden death of its CEO and co-founder while on a tour in India, is a good case in point that underscores one of the key risks that inheres in investing assets in cryptocurrency such as BITCOIN. The problem was that the only person who knew where the password for the offline vault that hosts $145 million in crypto-assets that belong to 10,000s of investors was Gerald Cotton, the late CEO. Upon his sudden death, the exchange is looking for ways of recovering the assets to repay its investors, a process that has so far bore no fruits thanks largely to efforts made to ensure maximum security for such assets. Obviously, such measures were in part motivated by, and deemed necessary, as an appropriate to response a series of attacks on online cryptocurrency exchanges in various parts of the world, reportedly earlier in this paper (Shane, February 6, 2019). One can hardly imagine the ramifications of such an event were one of the systemic importantly banks to be affected by such a problem that ironically arises from efforts to ensure maximum security for client assets as per the mandate invested in them.

Indeed, fraudsters have a new conduit to perpetrate their illicit activities, as the growing number of frauds that are perpetrated in part or wholly through Blockchain technology platforms in general and cryptocurrency secrecy. There is no better example of that than the case that involved Mr. Arthur Budovsky, of the Costa Rica Liberty Reserve platform who in 2016 was sentenced to 20 years in US jail for money laundering a staggering US$ 6 billion (Katz, January 28, 2019). Surprising though the figure involved maybe, the top secrecy that has earned BCT platforms keen interest from individuals and enterprises involved in illicit activities meaning that what has so far been exposed may be just the small tail that hides a far bigger problem; has raised concern over whether national and international financial regulators, today, already have what it takes to prevent such malpractices before they do much ruin to the financial sector that is still recovering from the turmoil that had its origin in US Subprime housing credit market slightly over a decade ago. The act of financial regulators playing catch up with financial innovations as was evident in the Global financial crisis, and unfortunately a repeat of similar fates in previous crises, at the national, regional, and global alike, is as costly, disruptive, and destructive of many lives, humbles economies, and by extension, public misery and an important source of frustration that is the fertile ground for populism.

There is little doubt that any digitization initiatives are bound to change power and relations in the organization, values that all members share, and how things are done. In other words, changing from a silo-based analog organization to sharing empowering digitization processes, is likely to create winners and losers. It is the role of bank management to galvanize the entire organization toward change by communicating the need and importance of the strategy for the organization, benefits that accrue to the organization in general and to functions and activities that involve individual employees, and how that will lead to higher organizational competitiveness and firm value; source of financial resources to finance the initiatives; and opportunity for employee

development to enhance their skillsets in line with requirements on the job digitization creates.

The enormous cost of acquiring, developing, deploying[38], and maintaining the latest digitization technology and tools is another factor. While on paper, the benefits that digitization-based financial inclusion initiatives are obvious, the high investment cost that generates initially little return on investment in the short term, and increases as scaling takes shape, has become an obstacle for banks that despite being cognizant of the vital role of such initiatives to corporate growth and development, are still not sure how best exploit its potential to the maximum. Such enormous cost threatens to cut deeper into already narrow margins that general banks are enjoying due to inroads that FinTechs are making into interest-earning business lines (lending). To mitigate the drastic impact on bank operations and profitability, a gradual, two-speed approach, is recommended in many instances, simply because, deploying digitization in a big bang manner in all organizational functions at the same time, is not only expensive but can also lead to serious disruptions that may overwhelm the organization (in terms of resources required); human resources (developing the skillset required); and business strategy at the business unit and corporate level, which may undermine organizational competitiveness in the short term.

To that end, a two-speed approach that at first involves the rolling out of digitization program in functions such as finance, research and development, and marketing, where investment made yields almost immediate return, followed by other functions and activities in the order of importance with respect to the contribution made toward digitization initiatives. Nonetheless, if an organization faces a serious onslaught on its core business, and it has the resources (physical infrastructure and talent both in-house and sourced externally) to implement an organization-wide, all-function digitization program, it can go ahead to develop and deploy such a program. The problem is that digitization being firm specific which means that there is no one size that fits all. The implication is that any error in identifying, formulating, implementing a strategy and deployment of the wrong technology is irreversible, and may be extremely costly to not only the firm's competitiveness but its very survival as a going concern.

The option some banks have chosen is to outsource some aspects of their value chain which they consider to contribute low value to firm revenues, and a good number of other banks in light of advances in technology and data capabilities, have opted to forge collaborative arrangements with specialist supplies of technology, cloud computing services, and established partnerships with technology companies in the development and delivery of financial products.

Nonetheless, there is a hidden long-term problem for banks to open their core business such as the development and delivery of financial products and services to suppliers, whether this takes the form of traditional supplier agreements, collaborative and partnership agreements, or outsourcing contracts. The problems lies in the possibility that the supplier may in the long term become too powerful and decide to become a direct competitor in the development and delivery of the products and services the bank currently considers its core business (the case of Samsung and Apple corporation is still fresh in our minds); suppliers or companies involved in collaborative or partnership arrangements may use insights they get from data on bank operations and performance to enter the same business on their own; outsourcing data and system architecture creates strong dependency on the supplier's technology and applications that prevents the bank from reaping advantages from the latest developments in data and technology due largely to rigid contracts that are aimed at safeguarding supplier proprietary assets; there is another probability that outsourcing or collaborative arrangements that involve the collection and storage of key performance data have the potential to create threats to core business value as suppliers and partners may sell data insights to competitors, or decide to enter the industry thanks to the higher competitive edge they have with respect to data and technology capabilities.

To reduce the likelihood that in an attempt by the bank to strengthen its competitive edge by joining or establishing an ecosystem that delivers an integrated host of services that meet customer core needs thereby contributing to a wealthier experience than is the case with offering a few distinct disjointed services the bank may create new and stronger competitors, there is need for banks to retain control of data and system architecture and technology, which is essential for the bank to obtain insights from data analytics that are key to improve performance, enter new segments and develop and deploy new product and service offers (Buia, Heyning & Lander, 2018). To reduce the possibility of becoming dependent and locked in on the technology of a single strong supplier, the bank can spread the services to various suppliers under flexible supply, collaborative and partnership contracts and arrangements that are underpinned by open-source technology rather than proprietary, firm-specific assets. Such an approach enables the bank to have in place agile data and architecture systems due to the ease of switching and implementing the latest iterations of the technology and services at low cost (Buia, Heyning & Lander, 2018: 4-6).

Digitization has many advantages as mentioned earlier, but is also prone to manipulation, misrepresentation, and criminality, unless appropriate control and security arrangements are embedded, incorporated, and implemented in the design, development and deployment of platforms, and applications; and meticulously and comprehensively written out in collaboration, partnership and outsourcing contracts and agreements. A good case in point of what can go horribly wrong if sufficient precautions are not put in place is the rapid rise in cases involving illegal lending web and mobile-based platforms that have defrauded their clients in Indonesia[39](Suryono et al. 2019), and caused substantial loss for borrowers in India (Thanawala, February 11, 2020), which among other factors sparked the Reserve Bank of India into action to strengthen regulation on P2P lending platforms practices, activities, and accountability (Kaur, December 20, 2019), and many cases where risky borrowers take advantage of informational asymmetry to borrow the amount they cannot repay leading to the bankruptcy of lending platforms (Klein et al. 2021).

Such a development, while directly impacts customers some of who lose the entirety of their lifetime savings, it must be noted that, unless the probability of recurrence of such problems in future is reduced and if possible eliminated for instance by tightening stringency of opening new platform financial service firms, 24/7 monitoring and supervision of their activities, performance, and financial reports, as well as requiring financial service providers to adopt standard governance mechanisms such as the G20 high-level principles for digital financial inclusion (GPFI, 2016; UK Finance, 2018), but also specifically implement the 10 G20 High-level principles on financial consumer protection[40](OECD, 2011); such scams pose serious danger of creating high public distrust in not only peer to peer lending mediated through online platforms, but also crucially financial services delivered via web and mobile platforms in general.

Yet risk from digitization for the banking industry is not limited to the above but also arises from the development of new financial products and services that are leveraging the latest technological advances in the development and deployment of financial products and services. The adoption and deployment of machine learning, internet of things (IoT), cloud computing, processing, analysis and storage services, which coupled with artificial intelligence and BCT, are expected to contribute to hefty benefits to the bottom line thanks to increased scope, scaling and automation possibilities of the digitization initiative.

Nonetheless, the downside of the exponential growth in the array of digitalization technological tools underpinned by the big data wave is the increase in the likelihood of data breaches a firm faces, and attendant capital costs that rise with the number of records breached, duration of a firm takes to identify the breach, and the time it takes the firm to implement countermeasures. Such fears are corroborated in a report issued by Basel Committee on Banking Supervision (BCBS) argues (BCBS, 2018; UK Finance, 2018), the digitization and financial technology revolution, poses "strategic risk, operational risk, cyber-risk and compliance risk, for banks." To reduce the probability of occurrence of such risks, banks are required to put in place "governance structures and risk management processes that appropriately identify, manage and monitor risks".

Conducting business through digital platforms has another vulnerability, which is the susceptibility to cyber-attacks and other cyber security infractions and private concerns[41]. One of the sources of firm value from digitization programs is data sharing capability both within the organization and between organizational functions and external sources working on collaborative products

and services (such as application programming interface, and platform business models, among others). It must also be noted that banking operations are increasingly relying on outsourced technical operations of financial services, which has led to commoditization and modularization of banking operations. Such a development which yields benefits from cost reduction enhances operational flexibility and resilience the downside is that banks open their operational systems to third parties with the consequence of generating liabilities and risks that banks must pay if they occur (BCBS, 2018:5). One of the value-added enhancers in financial service provision is increasing deployment of internet of things (IoT). IoT enhances data and information collection, communication, sharing and transfer in real time, which in turn strengthens the capacity to leverage data analytics to 'anticipate needs, solve problems and improve efficiency.' IoT by facilitating connections among various digital devices in bank premises, and between banking institutions and designated targets such as customers, suppliers, and partners thereby creating a seamless 24/7 flow of information that can help in quickening decision-making, low cost, and increase efficiency.

Some of the areas where IoT is making inroads, according to xcubelabs(July 201, 2016), include loan application process through an agreement between the bank and its client that allows the former to install sensors in the home of the latter to monitor the condition of the house while the client is given the option to send additional relevant documents to support the process for mortgages; using Bluetooth low energy technology to monitor customer transactions in context enabling the bank to offer loans that are informed by customer needs as discerned from items being searched while shopping, which increases personalized financial service delivery that augments customer experience; reducing the probability of fraudulent activities, by transmitting particulars of the customer through immutably encrypted messages; foster effective monitoring of customer assets (collateral) by transmitting information of the condition of assets of interest, send information to the bank to support repairs that banks use to quicken loans for such purpose; provision of insurance policies that are based on data on vehicle usage which ae sent to the bank/insurance company and vendor(regular tracking driving habits, condition of vehicle parts, incidents and son), which lowers possibility of fraudulent claims, cost of assessing repair claims, hence increases efficiency and value added.

With the support of augmented reality (AR), repairs are effected without the need for mechanics to make physical visits to the location where the vehicle is located, which reduces costs significantly. IoT is also helping customers to place orders of household items by linking customer's bank accounts with devises retrofitted with sensors in the customer's home that need regular refilling (such as refrigerators), and by using artificial intelligence-empowered devises that can send purchasing orders through remote voice commands (Amazon Echo and Alexa, and Google's Home).

While the benefits are limitless, the dangers of IoT cannot be underestimated, the most important being vulnerability to data breaches which can cost banking institutions enormous costs in liability as well as leaked secrets of bank confidential information on such issues as business current and future strategy, invaluable intangible assets, customer information and data; increasing susceptibility to "private violations, erratic automated processes, discriminatory model outcomes"(Levy, While & Helbekkmo, 2019). All that culminate into a loss of public confidence, which is compounded by huge costs in fines from financial institution regulators and paying liability suits. If such a breach cascades in the entire financial system, financial stability while may not immediately face a crisis, may an increase in the cost of funds as customers choose other investment alternatives. Inevitably, lesser third-party deposits and borrowing from the banking systems weaken the role of banks in transmitting monetary policy signals, which should undermine financial stability.

Thus, There is little doubt that as the World awaits the launching and eventually, the coming into the mainstream of 5G internet, pundits on internet security are warning of the potential security risks of placing so much personal and confidential data and information in clouds and networks that will be instantly accessible from all corners of the Globe at high speed, low latency, and in a bi-directional manner (Sims, 2018).

In an IBM-Ponemon Institute report (2018) on data breaches conducted in 15 countries in Five continents, results revealed an increase in the average total cost of a data breach was US $3.62 million (2018) compared to US $3.62 million (2017) an increase of 6.4 percent; a 4.8 percent increase in the average cost of data record breached from US $141 (2017) to US $148 (2018); and an increase of 2.2 percent in the size of data breaches. The report also revealed another worrying trend, which is the increase in the likelihood that a material breach will occur in the next 2 years from 27.7 percent (2017) to 27.9 percent (2018); a higher cost (US $ 1 million on average) for companies that take longer to identify and contain the data breach (more than 30 days) than those with the capacity to detect and contain the data beach sooner (less than 30 days after it occurred).

While the full deployment of automation of data security reduces the average total cost of data breach from US$4.43 million to US$2.88 million, extensive use of IoT increases the cost of every record breached by US$5, US$40 million for a mega breach that involves 1 million records and US$350 million for a mega data breach involving 50 million records. Much headway has been achieved in the development and deployment of hacker-proof cryptographically based encryption and automated security, which should reduce the likelihood of data loss and compromise of business systems to bad elements and competitors. Nonetheless, the recent hacking of Bitcoin exchanges in Japan and South Korea has brought such concerns to the fore once again. The problem that is increasingly becoming important and worrying however is the danger that digitization programs increase the chance that custodians of customer data may be forced to release them under duress to authorities without the consent of data owners.

While many customers may not feel worried about allowing their data to be accessed by companies that have the objective of using them to improve and enhance their experiences through new product and service development or enhancing product attributes that are based on customer needs and preferences (personalized product offers), very few customers are willing to allow their data to be accessed by governments for other reasons other than verifying the likelihood of criminal activities. And this is exactly what is happening. A good case of Uganda serves to illustrate how a well-intentioned, private sector-based initiative faces the danger of being undermined by government policy. The Uganda government perhaps, pressured into action by established banking institutions who see digitization as a serious threat to their core businesses, concern that mobile money accounts may serve as conduits of money fraud and other organized criminal activities, in a proposed amendment to the excise duty tax, proposes to impose tax on transactions that use mobile money accounts. The government proposed a tax of 1 percent (the Minister of finance had proposed a 0.5 percent tax), which was later passed in parliament, on any transaction that involves receiving and sending money, paying water, electricity bills, and school fees using mobile money accounts. And that is in addition to a withholding tax of 10 percent (raised from 6 percent), imposed on telecom service providers on airtime distribution and mobile money services (Price Water House Coopers, 2018).

Uganda, like many developing countries, suffers from high financial inclusion, with only 5 million bank accounts for a population of more than 34 million. Yet thanks to mobile technology, there are 22.8 million active mobile money accounts in Uganda (June 2018), with a total value of Uganda shillings 2.8 trillion (more than 50 percent of the country's GDP). The policy illustrates how easily people who hold authority in the land or powers that- be, to put it bluntly, can easily devise ways that are based on the state of art technology that exploits the working and architecture of digital products to intervene in cases that are based on digitization than was the case during the analog technology dominated era. For instance, if some authoritarian regime wants to clamp down on mobile phone connectivity, the only thing the government has to do is to issue a directive on service providers to shut down servers or in the event of taxing mobile communications messages, is a regulation to mobile phone service providers to effect the addition of the fee on any transaction that mobile money account owner makes. In other words, the latter case tantamount to is personal tax, regressive at that, that is exacted through a third party, without the written consent of the account owner. It is not difficult to see the detrimental effect that such a policy will have on the future of

mobile money use in Uganda in future. This is because, if the government can impose an arbitrary tax on mobile money accounts with the need to seek the consent of the account owner first, is not it also possible that the same government can issue a rule that orders telecommunications companies to suspend users from having access to their accounts or even pressure them to surrender such accounts to the government. The case in Greece in 2011 where all of a sudden, the government issued a regulation that ordered banks to desist from allowing customers to withdraw their money from their bank accounts as one of the ways to stem bank runs, is a good but bitter reminder.

Based on an assessment of the contribution of FINTECHs to determinants of systemic risk as delineated by Thomson(2010), shows that based on Europe and US data, FINTECHs have yet to pose a systemic risk to financial systems (Franco et al., 2020). This is due to the still small size of fintech transactions (US$4.33 trillion by 2018) compared with total assets of financial sectors; the decentralized mode of operations, low correlation of activities conducted by FINTECHS on their own as well as collaborations with incumbents in delivering financial services; a large number of FinTechs involved in delivering various financial services means still low concentration and substitution risk in financial services delivered, low condition and context systemic risk (Franco et al, 2020).

Nonetheless, the growing number of cases where customers of mobile and platform money market accounts lose access to their savings is a very serious cause for concern. Similarly, the rising restiveness in peer-to-peer online lending and borrowing platforms due to complaints of extortive interest terms, the malpractice of unilaterally changing covenants at will, and the use of debt collectors in pursuing repayment(Cahyani, 2018), constitute elements on a long list on the catalogue of problems that users of seemingly quick and easy online platforms are having to face after trusting newly founded fintech industry to solve their financial constraints (Danang, November 25, 2018). This is not to mention, the rise in non-performing loans, which financial tech platforms recorded over the past year in Indonesia (1.45 percent), which if left unchecked has the potential to pose a risk to the financial sector through the back door, to put it mildly.

Inevitably, that makes financial tech performance a new front for financial system supervisors and regulators, thus, adding another veneer of complexity to the immense responsibilities on which they must keep a watchful eye daily. Doubtless, the plethora of problems has emerged as a result of the little understanding most users of fintech services have about the business model as distinct from the traditional 24/7 regulated and supervised banking industry, the absence of effective control and supervisory arrangements that must be flexible to take account of both the constantly changing market and operating environment facing FinTechs and ensuring sufficient stability to prevent rising uncertainty that may directly and otherwise adversely impact the traditional banking industry, financial sector and economy. Another thorny issue to date is the failure of financial sector regulatory authorities to oblige providers of the web platform and mobile-based financial services to establish governance structures in a timely manner that would ensure easy and early detection of risks before they culminate into intractable behemoths that may threaten the entire financial system and by extension, the economy (Amelia, 2018; Rivers & Mullen, 2018). Putting in place governance structures would ensure transparency and disclosure of firm information, performance, nuts and bolts of the business models used, business process, risk management processes, and financial positions that can be gleaned from firm asset and liability accounts, all of which would provide predictability of the direction of firm performance.

VI. Conclusion

The thrust of this article is the impact that Block Chain Technology (BCT) based development and deployment of financial services on financial stability. There is no doubt that digitization, which is influenced and accelerated by the ICT revolution, has deepened financial development as new players in the form of FinTechs and technology companies have entered financial service provision, providing customers with an increase in product and service variety and ever declining cost due to competition between traditional financial service providers and nonconventional new entrants; enabled the adoption financial institution to adopt new business models that are leveraging on data collection, storage, sharing, and discerning actionable insights; accelerated and strengthened financial inclusion initiatives thanks to the ease of use, flexibility, affordability, and security; speedier and low cost; cross-selling other financial services the financial service offers ranging from mortgages, insurance, financial planning, investment management, which has contributed to higher educational attainment, financial literacy and human capital and that in turn have been associated with an inclusive growth, higher household incomes, significant decline in poverty and income inequality.

Digitization and ICT, have also enabled financial institutions to develop and deploy API driven Open banking and direct banking business models which generates that include more diversified customer base, new collaboration possibilities with both banking and non-banking companies, enhanced ways to leverage customer experience of both existing and new ones, creation of new services; enhanced capacity and capability to meet an increased array of customer needs; enabling banks to reduce customer churn; and increase the share of banks in their customers' wallet through upselling and cross-selling of services. Moreover, through aggregation platforms that automatically standardize and normalize financial data, banks have an added advantage they can use to leverage data analytics tools to offer new services that complement different hence idiosyncratically driven customer journeys. That should sound good news for stronger bank health, which should also be vital for the bank sector and financial system health. BCT and benefits that are associated with enhanced cyber security, decentralized authentication, increased operational efficiency, low compliance cost, shorter onboarding rates of new product and services offers, a new set of product offers in the form of crypto assets that should diversify asset portfolios, increase variety of revenue sources, hence resilience in the event of a slowdown in one or so bank's business lines. Trackability of transactions and assets in real time, around the clock, which coupled with the immutability of any activities that are authorized by network participants, are features that can add to an array of product offers, business processes, reinvigorate business models, hence good for financial stability.

Nonetheless, potential dangers from increasing digitization to financial stability cannot be underestimated. The rise in the involvement of FinTechs and TELCOs in the delivery of financial services poses financial stability risks that are attributable to the reduction of interest-based income sources for banks as FinTechs and TELCOS are leveraging their large customer databases to offer saving and lending services, peer to peer payments' services, and money transfer services; undermining the ability of banks to function as monetary policy transmission channel due to their declining importance in domestic credit creation, money supply transmission through holding third party deposits, buyers of government bonds, and reduced potency of the level of excess reserves general banks hold in central banks on liquidity in the financial system.

Meanwhile, with respect to API, potential risks arise from an increase in partner and counterparty risk, technology incompatibility risks and attendant domino effects on other players in the financial system; fears of opening businesses to competitors (Diamond et al. 2019); and uncertainty of long term profitability of platform-based business models in the aftermath of breaking down the organization into smaller, coherent business units that are required in developing APIs and platforms. BCT-related risks to financial stability, are likely to arise from the rising vulnerability of BCT to hacking, theft, and data breaches rises concerns from critics of the secretive, decentralized distributed record-keeping, anonymous, low cost, double encryption hyped platform network-based transactions and are increasingly raising worst fears of financial institutions that are participants of falling foul of compliance requirements, creating costly sources of reputation risk, which barring the existence of effective response and recovery functions in the affected institution, may culminate into potential financial ruin, and by turn pose both direct and indirect danger to financial stability.

The only way forward is to follow the adage that 'if you can't beat them join them.' The only way traditional banks can not only survive but thrive in the current business environment is for them to pull up their act in digitalization. This is because while time may seem to be on their side, there is no certainty that unless the traditional banks accelerate and deepen their digitization strategies through a multipronged approach, including revamping backend and frontend technology, gradually but at an increasingly expeditious rate damping the conventional banking business model, strengthening collaboration in product and service delivery and attendant technology, discarding the bank is king and adopting the customer-centrism is the only source of sustainable value mantra.

Not doing that there is no certainty that in ten years or less, we will not be reminiscing about what would have been had banks listened and leveraged up their capabilities and inherent advantages to rise to the challenge TELCOS and FinTechs pose to their erstwhile seemingly entrenched unassailable formidable fortresses in financial services delivery.

Notes

1. Defined as stored codes that are only accessible electronically (Narian & Moretti, 2022)
2. https://qris.id/homepage/
3. https://www.bi.go.id/id/fungsi-utama/sistem-pembayaran/ritel/infrastruktur/default.aspx
4. Defined as the application of computer and internet to boost the efficiency and effectiveness of value creation process by improving and enhancing firm operations, interactions, and configuration of economic value
5. The former being the movement from analog to digital data for streamlining existing firm processes, while the latter relates to the deployment of digital technologies and communications in business models to enhance firm competitiveness through changes in customer relations, internal processes and value propositions (Ross, 2017; Ritter, Pedersen & Sorenson, 2016; Ritter & Pedersen, 2020; Brennen & Kreiss, 2016)
6. In a blog on benefits of artificial intelligence in banking,*S*molaks(2020) argues that emotion AI, by using behavioral prediction algorithms, provides banks that deploy the technology with insights that are discernible from the cadence, pattern, and behavior in past calls of the voice of the customer to recommend course of action for customer service agents to take, as well as helping in predicting purchasing and payment behavior, to inform credit application decisions, and vital support in effecting proactive fraud detection and deterrence.
7. World Bank(2018)
8. Deep shift: Technology tipping points and societal impact, World Economic Forum, September 2015, weforum.org.
9. Bitcoin, like other cryptocurrencies(others include ripple, Bitcoin cash, EOS, Stellar, Litecoin, Cardano, Monero, TRON, and ethereum), have been battered by speculative activity caused by uncertainty of their intrinsic /fundamental values, with the most recent hacks that affected several crypto currency exchanges doing little to assuage such fears; steep decline in prices since the beginning of the year that has increased reluctance of institutional investors to consider the crypto asset as a stable return investment; resistance from financial system regulators due to blatant shunning of regulation and centralized control, new found fame largely attributable to strong adherence to the anonymity that participants on the platform enjoy to both fellow participants (with the exception of public keys that other participants use as reference to determine the participant involved in an instance on the platform), and non-participants. It is an attribute that has raised serious concerns from regulatory and transnational crime fighting agencies about the high possibility of the platform becoming a bastion and conduit of money laundering and other illicit activities, at a time when global efforts are underway to exactly counter such activities (Upadhyay,October 17, 2018).
10. This is despite the wholesome confidence that cryptocurrency prospects received, hence investors and experts, that associate the landmark decision made by the Singapore government which in late September 2018 when it launched its first cryptocurrency coin. The move, which is the first by country is being marketed by the CashlessPay Group with effect from October 25, 2018
11. http://hyperledger-fabric.readthedocs.io/en/latest/identity/identity.html
12. https://www.hyperledger.org/
13. It is both the anonymity and failure of bitcoin networks to put in place sufficient cybersecurity mechanisms that are to blame for the increasing frequency of bitcoin hacks that have hit several virtual currency networks such as Coincheck exchange based in Japan, which lost US$500 million in cryptocurrency in late 2017, CoinRail cryptocurrency exchange based in South Korea in Mid-June 2018, that saw it losing more than 30 percent of its cryptocurrency, and Bithumb virtual currency exchange, based South Korea which was defrauded of US$30 million of its virtual currency. This is a point that Adriano (2018) also notes when he cites evidence that since 2011, more than I millions of Bitcoin (valued at US$ 9 billion by May 2017), was stolen from a number of exchanges.
14. This point can be illustrated by an example drawn from blockchain. While blockchain technology has strong and proven cybersecurity features, one way to increase its commercial value is to widen the variety of crypto assets stored and traded among participants. As most assets are physical in nature, the only way they can be converted into crypto assets is to use Internet of Things technology that beams messages to and from the assets to reflect changes in values of such assets that a consequence of transactions on respective blockchain. As it has already become evident, IoT technology is highly prone to hacks due to the various transmission media that signals from the assets are move to and from the asset to the blockchain (Mullen, 2018)
15. Bitcoin which once stood at nearly US$20,000 ($19,783.21 to be exact, on December 17, 2017),contributing to nearly 48 percent of global cyprtocurrency valuation at the time Kharpal, August 07, 2018), by June 2018 had dropped to US$6000 and by November 25, 2018 traded at US$3800 cryptocurrency exchanges. The fate of other cryptocurrencies with lesser contribution to cryptocurrency market capitalization such as ethereum have faced an even worse hammering reflected by deep decline in selling price of under US$100 on the same date. The drastic decline is largely due to a deep draw in the cryptocurrency market by nearly US$63 Billion in spell of just seven days as Young (March 25, 2018) reports. Uncertainty has not been helped by a drastic decline in confidence in the cryptocurrency's long term value as an asset class. "In every bubble-to-build-to-rally cycle in crypto, newcomers and investors suffer intensely, both psychologically and financially. It is entirely possible for institutional investors to lead the next rally in crypto but for investors that were affected by the recent crash to invest in crypto could take time," Young(2018) puts it aptly.
16. http://hyperledger-fabric.readthedocs.io/en/latest/identity/identity.html
17. Regulators on business networks conduct oversight over transactions that occur along the network, hence have more access rights than individual participants, the same applies to operators and administrators
18. https://www.investinblockchain.com/how-does-cryptography-protect-blockchain/
19. The sudden death of Gerald Cotten, the CEO of Quadriga Bitcoin exchange in Canada , and the imbroglio its created due to the difficulties to have access to US$145 million in investors' Cryptocurrency assets is a good case in point (Shane, February 06, 2019)
20. Permissioned private blockchains are hosted on private computing networks, where access is controlled and editing rights are entrusted to authorized parties (Carson, 2018)
21. In general, charges that users pay for using Google Cloud Platforms either computing engines, cloud storage, API applications, objects, and transactions processing and events streaming services are based on usage, with long usage accorded heavy discounts in many cases. Public blockchains, while offer limited cloud facilities are in general free of charge
22. The case of the recently implemented General Data protection Regulation (EU 2016/679) sets the highest bar on obligations it sets for institutions that collect, process, use, and store personally identifiable information (PII), (natural person not legal persons), that should comply with several key principles , inter alia lawfulness principle (data processing should only be done if there is legal basis to do so such as having consent from the individual, meeting legal obligation, or fulfilling requirement of a contract); fairness principle(date processing should be done on condition that the

institution that does the processing provides individuals whose data it processes with sufficient information about the processing, and ways they can exercise their rights, including right to reject or seek to know what data is processed and for what purpose, and right to request deletion of data; transparency principle (information that users of PII data should be concise and in formats that easy to read and understand; principle of purpose limitation(collecting personal data should be related to a specific purpose, explicit, and for a legitimate purpose and should not be subjected to further processing; data minimization principle(personal data collection should not exceed adequacy, and relevancy requirements, and must not go beyond the purpose for which it is collected; accuracy principle(data should be accurate and kept up to date; storage limitation principle(data should only be kept in formats that allow permits personal identification as long as it is necessary to do so; security principle(data processing should be done in a manner that ensures security and protection against unauthorized access, processing, accidental loss, damage and destruction; and accountability principle(data controller or data protection officer the party that should be held to account in case of failure compliance with GDPR principles). Failure for an institution to comply with GDPR provisions makes it liable to a hefty fine that is in the order of 4 percent of its global revenue (EU, May 2018).

23. In a case involving Paige Thomson who hacked 100 million and 6 million accounts of Capital One customers in March 2019, in a breach is expected to cost the company between US$100-150 million in technical costs, credit monitoring, and legal support, not to mention fines if either SEC or FTC or both establish sufficient evidence of noncompliance with prevailing data protection legislation to have influenced or facilitated the case
24. http://hyperledger-fabric.readthedocs.io/en/latest/build_network.html
25. https://www.dlt.sg/about-us/
26. The bond has Aaa/AAA rating, settlement data August 28, 2018; maturity data of August 28, 2020; and coupon 2.20% p.a. payable semi-annually in arrears
27. ibid
28. Currently through relating messages about the state of one blockchain to another (cross chain messaging), and facilitating exchange of tokens between users on the blockchain as well as across blockchains without the involvement of a third party (a process known as cross chain atomic swaps(Wachter & Hammer,2019).
29. Until Blockchain lightning, which makes possible speedy transactions that range between microseconds and a second, becomes mainstream, one of the key obstacles participants on blockchain face is limited throughput at any given time. The problem is attributable to the long time it takes (a minimum of 10 minutes) for each transaction to be completed right from initiation , the frenzied search for solution to the puzzle that eventually leads to the winner(mining), verification and appending of the transaction to the blockchain. The implication is that increase in volume of transactions is likely to reduce the speed of transaction even further, undermining scaling possibilities(https://cointelegraph.com/lightning-network-101/what-is-lightning-network-and-how-it-works).
30. The collapse of US$60 terraUSD (UST) and its token coin luna project, which its creators touted as an autonomously stable coin that was algorithmically pegged to the US dollar was as dramatic as it was far reaching in the reverberations its collapse unleashed. Instability of the luna triggered selloffs that pushed the UST peg to the brim until it could hold no longer considering the almost simultaneous frenzied exit of holders of the stablecoin that begun in April and peaked in late May 2022 breaking the UST 1 USD peg. Investors who had more faith in the resilience of the UST peg than the underlying code and Bitcoin reserves warranted lost billions. One of the most financially destabilizing aspects of UST was the fact that the more luna tokens were in circulation, the more it effectively increased the supply of the USD on the market (Sigalos, May 29, 2022).
31. While many central banks have expressed interest in central bank digital currency, perspectives and approaches vary widely. From the technical perspective, central banks can select an one of four CBDC architecture designs. Some central banks have expressed interest in adopting the hybrid design in which CBDC is a cash-like claim to the central bank, central bank manages the payment operations, central transactions ledgers, and back up infrastructure while with the private sector does all the customer retailing activities; a few central banks are opting for the direct CBDC design where the central banks operates the CBDC payment system including the retailing process; and the third approach which has attracted no interest and preference from any central bank so far, is the indirect CBDC design /intermediated CBDC design, where CBDC constitutes a claim to the central bank, central bank manages the wholesale ledger and not the central ledger of transactions, and the private sector conducts all payments. The indirect (synthetic design), involves CBDC that are claims to intermediaries that operate retail payments similar to narrow payment banks. Thus, customers have claims to the intermediaries that in turn have to back fully their liabilities to retail clients with claims on the central bank (Auer, et al., 2020,pg.18)
32. Which means that while Libra is underpinned by a secure blockchain network , backed by hard assets, its ledger system is not fully decentralized or autonomous which means that only members of the consortium that include Facebook , Master Card and PayPal) have the rights to verify and validate transactions. This is contrary to the stated goals of the digital currency which is to increase financial inclusion to those who are financially excluded who happen to be poor hence will have limited access to the private blockchain because of its ‘permissioned’ design protocol(Decambre, August 20, 2019)
33. API Strategy 101: What is an API? http://www.apiacademy.co/resources/api-strategy-lesson-101-what-is-an-api/
34. application developer is responsible for runtime, storage of application code, database, programming language, networking, bandwidth, security, and for non-plug-in APIs, application maintenance, and publicity of application to users
35. http://platformed.info/apis-platforms-how-interfaces-access-enable-networked-economy/
36. For which Facebook besides being required to implement risk management and personal data and information protection measures, Federal Transportation Commission (FTC) fined a record US$5 billion for “ designed not only to punish future violations but, more importantly, to change Facebook's entire privacy culture to decrease the likelihood of continued violations”(Fung, July 25, 2019). In another development related to Facebook data management culture(Fung, 2019), SEC fined the company US$100 million for what it called “ charges…for making misleading disclosures regarding the risk of misuse of Facebook user data.” In another data breach case that affected 147 million Equifax customers, FTC fined Equifax US$700 million , and obliges the credit data collection and rating agency to put in place a “comprehensive information security program (“Information Security Program”) designed to protect the security, confidentiality, and integrity of Personal Information” (FTC, July 23, 2019).
37. Personal data protection compliance requirements along other things require changing the organizational culture with respect to the personal data is collected, processed, stored, and shared; calls for the establishment of a data protection officer, which means higher costs for companies; maintaining contacts with sources of personal data on data collection, processing, use, and storage which is a throwback to the past hence contrary to current trends in all industries and sectors that are transforming from siloed data systems architectures to business models that are increasingly allow instantaneous, multi-format data collection, storage, processing and sharing that machine learning and artificial intelligence methods require to train, test and validate effective algorithms that are used to generate actionable insights
38. Which in most instances faces constraints that are associated with how to deploy a new system to replace legacy systems without causing disruption to business activities that may spark invite clients’ complaints, decline in effectiveness, and decline in firm as the new system takes over the analog based one. A strangler model is recommended but implementing that is not entirely free of problems that may reduce performance temporarily, which is not the kind of news that managers want customers to share with their friends.
39. The rapid increase in the number financial technology startups that are mediating lenders and borrowers (peer to peer lending), while led to increase in funds available for borrowing due to an increase in lenders, has also created new problems. Some of the problems, that OJK noted were the imposition of a high interest on loans (19 percent), which adversely impacts on borrowers’ ability to repay, a fact that is reflected in another problem, which is the rise in nonperforming loan rate from 1.2 percent in January 2018 from 0.8 percent in December 2017
40. The ten principles call for the establishment of a supportive Legal, Regulatory and Supervisory Framework (principles 1); stipulate the roles of oversight bodies in such a system (principles 2); call

for Equitable and Fair Treatment of Consumers(principles 3); Disclosure and Transparency (principle 4); conducting Financial Education and Awareness campaigns(principle 5); Responsible Business Conduct of Financial Services Providers and Authorized Agents (principles 6); Protection of Consumer Assets against Fraud and Misuse(principle 7); Protection of Consumer Data and Privacy(principle 8); opportunity for complaints Handling and Redress(principle 9); competition in delivery of financial services to provide consumers with wide choice of services, fair prices, and value for money(principle 10)

41. In one of the latest and audacious security breaches, Singhealth, the largest health case in the city state that is home to 5.6 million people, saw nonmedical data particulars for outpatients who paid visit to organization facilities during May 2015 - July 4 ,2018, totaling to 1.5 million clients, compromised (Joshua Berlinger, July 21, 2018). Information compromised during the hack included names, addresses, dates of birth of patients, and identity cards. However, Medical records of another 160,000 outpatients were also targeted. Names of people whose particulars were compromised included city state Prime Minister Mr. Lee Hsien Loong, reports Berlinger. And this happened in a country that boasts one of the best cyber security systems on planet earth. The episode has shown not only the audacity but the capabilities that hackers have developed to penetrate into systems that hitherto were considered impregnable against cyber-attacks.

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