

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

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Abstract

One of the challenges financial institutions is how to adapt to a changing business environment, increasingly demanding and differentiated customer preferences, digitalization and technological change. Using a documentary analysis approach, the article navigates the ramifications of API based open banking, Block Chain Technology (BCT) and entrance of Fintechs, Bigtechnology companies (Bigtechs) and Telecommunications companies (Telcos on the performance of general banking sector and financial system stability. Results underscore the role of digitalization revolution and ICT in fundamentally changing the financial service development and delivery, by empowering ICT savvy non-financial institutions including financial technology companies (Fintechs), TELCOS, and Bigtechs to become players in the industry; enhancement of financial inclusion thanks; reduction in transaction costs; and inducing traditional banks to adopt new business models that leverage Big Data and data analytics approach. Digitalization has paved way for the development of agile, adaptive open banking supporting business models financial that supported collaboration with other providers of financial services, back end and front end technologies, diversified customer base, strengthened capacity and capabilities to leverage customer experience, develop and deploy financial innovations to strengthen competitiveness. Nonetheless, despite its many benefits, most banks are yet to adopt BCT due to persisting uncertainty that surrounds the technology a, its adoption, deployment and operations. BCT adoption has been undermined by an array of failures of several BCT based crypto exchanges and assets, limited understanding of BCT business case, regulatory ambiguity, and risk aversion. The adoption of BCT promises improvement in the integrity and authenticity of financial service delivery, reduction in vulnerability to cyber insecurity, decentralized authentication, increased operational efficiency, low compliance cost, shorter onboarding of new product offers and customers, accelerated development and deployment of new product offers¹, which should diversify and broaden liability sources and investment portfolios. Failure to adopt and deploy both business processes and products on BCT poses the danger of empowering new entrants into financial service development and delivery. Traditional banks reluctance to adopt emerging technologies threatens their both their interest and non-earning income sources, ability to provide monetary policy transmission function, providing customer wealth custodianship services, serving financial payments and money supply transmission functions, and serving as lynchpin in financial system liquidity. The article highlights challenges and pathways to mitigating them in such a manner that improves bank performance without undermining financial system stability.

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I. Introduction

Product and process innovations are pivotal for growth, productivity, profitability and competitiveness, albeit unleashing creative disruption in the process (Ziemnowicz, 2013). Based on market, technology and degree of change required, extant literature identifies four types of innovations as a spectrum that ranges from incremental, disruptive, architectural to radical (Lopez, June 29, 2015). Innovations take various forms including new products, processes, markets, inputs, organization structures, and business models. The onset of deregulation and globalization of markets in early 1980s generated an increase in competition in factor and product markets, which coupled with the age of the internet, spurred innovations in products, business processes and business models. Business model innovations transform the way businesses produce and deliver products and services (business processes), managerial practices and processes to achieve the highest efficiency, and factoring in not only internal stakeholders in organizational decisions but also, principally customer preferences, competitor strategies and offers and regulatory agencies.

Nonetheless, the impact of the 1997 Asian financial Crisis which was aggravated by pervasive mismanagement of the banking sector, on not banks but also financial sectors, economies and society, fundamentally changed attitude toward risk taking in the financial sector. Risk aversion is today embedded in national banking laws, and provisions, attributes, standards and principles of standard setting bodies. It thus apparent that considering the attitude of practitioners in the general banking industry, regulatory and supervisory agencies, and the general public, banks are facing formidable challenges to adopt to the new financial services delivery regime that requires transforming business models, take aggressive steps to exploit new opportunities, compete vigorously with new financial service providers, all that without flouting existing laws, regulation and principles of prudential banking and undermine public confidence.

Business model innovations are crucial to transforming production and business processes; instituting and sustaining agility and adaptability in managerial practices to align with an increasingly dynamic, demanding and complex business environment; and laying firm foundation for nurturing and accommodating technological change (Serrat, 2017). Four theories of innovation lay the groundwork for understanding the process and impact of innovations on businesses, industry and society. The innovation diffusion theory propounded by Rogers, considers innovation to comprise for components including the innovation, communication media used to disseminate the innovation information, the social system context that underpin adoption and non-adoption, and time required to adopt the innovation. Innovation adoption is dependent on its relative advantage, compatibility, complexity, trialability, and observability (Ham, 2018).

Meanwhile, the Concerned based innovation adoption model (CBAM) underscores the importance of addressing various aspects of concerns of stakeholders impacted by and those charged with implementing the envisaged change for a successful process. CBAM has three components including stages of concern (SoC), levels of use (LoU), and innovation configuration (IC). SoC refers to characteristics of adopters, while LoU and IC refers to innovation characteristics. Thus, CBAM considers characteristics of adopters and how their concerns are addressed and the characteristic

features of the innovation to be crucial for successful adoption of service innovations (American Institute for Research, 2010).

The technology acceptable model argues the importance of the prospective adopter's attitude and expectations in influencing the adoption (Davis, 1985, 1989). Specifically, factors that relate to ease of use and potential usefulness of an innovation influence adoption, with the latter showing a higher correlation than the former with technology adoption than the former. Meanwhile, according to the Chocolate model (Dormant, 2011), looks at innovation and the change it envisages for an organization as two inseparable components. The model comprises for components including change, adopters, the change agent(s), and the organization, hence the acronym (CACAO). To that end, the chocolate model requires sequential analysis of the change, adopters of the change which includes developing a change plan; identifying the change agents; assessing the organization that is the target of the innovation, and making necessary revision in the plan to incorporate organization analysis outcomes.

Despite some differences, the four theories share some similarities. Such similarities are discernible from the emphasis placed on analyzing the rationale for the innovation as reflected in usefulness and relevance, impact on interests of adopters and those charged with implementing it, and compatibility with adopters and the organization. Celner(2020) of Deloitte identifies several key drivers to bank performance and competitiveness during the digital transformation age. The list includes the need to become data centric and leverage data analytics while protecting personal and business data integrity from cyberthreats; embracing emerging technologies in business processes, functions and relationships; leverage platforms and data monetization; develop agility and flexibility in adopting adaptive business models; the demand for a customer centric strategy; readiness to embrace ecosystem framework; future of work that is increasingly being characterized by automation of routine tasks, employee empowerment and participation in key decision making processes, and demand for diversity, inclusion, and equality.

In the same vein, the Economist (Lin et al. 2022) identifies imperatives for bank performance for the next seven years to include developing a business strategy that is aligned with purpose and profitability, customer values, and corporate responsibility for the environment and social values. Moreover, banks face other challenges in their operations ranging from accelerating digitalization, disruption for financial technology companies and big technology and telecommunications companies, uncertainty arising from digital currencies and related investments, brazen waves of cyberattacks (Lin et al. 2022,6). Social and impact investors are increasingly selective in choosing investments as they are rating candidates based on performance on corporate social responsibility (CSR), environmental, social and governance (ESG), and increasingly track record on diversity, equality and inclusion and equality (DEI) issues.

Meanwhile, the regulatory and supervisory regime, is taking measures to strengthen provisions on asset risk weighted capital and liquidity requirements to factor in rising risk sources from the spate of unregulated digital financial products and business models. Thus, banks face formidable challenges that are attributable to the rapid and fundamentally changing configuration of markets, customers, array of financial service providers, products and services, evolving regulatory and supervisory regime requirements. It is only by rethinking and reinventing banking, corporate purpose, customer relations, products and services offered, and business strategy, that the general banking sector has the chance of remaining relevant and key player in the rapidly changing financial sector landscape.

The paper contributes to literature on the impact of the interaction among key drivers of competition in the digitalization era in financial service development and delivery, changing configuration of the market for financial products, and evolution of emerging technologies on operations and performance of general banks and the impact of that on financial system stability. Banks face formidable challenges that are attributable to legacy systems, high risk aversion adopted as a response to 1997 East Asian economic crisis, stringent retrospective looking regulatory and supervisory regime in a real-time, data analytics driven and informed regime; and rapid changes in the competition landscape, largely motivated by reaction to changes in financial innovations than have provided opportunities for new financial service players. Ironically, while the financial regulatory regime has created new opportunities for new players to operate, it is yet to relax stringent regulations imposed on general banks in conducting their businesses. This hampers the readiness of banks to adopt new business models, revamp business processes, develop new sources of non-interest income, and develop agile business strategies that are responsive to changing customer and society values, open banking and direct banking, the need to forge strategic alliances with new entrants in product development, entering new markets, and in procuring and managing backend technology provision. The paper also leverages findings to propose pathways for banks respond to changing financial sector landscape while at the same continuing to serve as an anchor of financial system stability.

Digitalization is going mainstream, affecting our daily working, lifestyles, and interpersonal interactions. Manifestations of changing business competition in financial services provision are increasingly evident in the number of new players entering the industry ranging from post offices, telecommunications companies (TELCOS), technology companies (Bigtechs), financial technology startups (Fintechs). What is common among most entrants is the ability to leverage data analytics to align business strategy and product and service offers with customer needs, experiences and expectations that is far beyond what traditional financial service offers. The main drivers of Fundamental change in operating and business environment which has created such opportunities for new comers into financial provision is the availability of emerging economies.

Doubtless, the speed of advancement, adoption and deployment of emerging technologies has become an important driver of the fundamental changes in ways financial and nonfinancial institutions are reimagining, redefining and conducting businesses today. PWC (2022) identifies eight essential technologies that are crucial to the process including "artificial intelligence (AI), augmented reality (AR), blockchain, drones, Internet of Things (IoT), robotics, 3D printing and virtual reality (VR)". The technologies 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 through fostering reconfiguration of convergencies in the use of technology as manifested in automated trust, immersive interfaces, extended reality, working autonomy, digital reflection n and hyperconnected networks" (PWC, 2022, pg. 28). The focus of this paper is to examine the influence of block chain technology, open banking, and crypto assets, and the involvement of Fintechs, Bigtechs and Telcos in financial activities, on traditional banking operations and performance, and financial system stability.

In their research on factors that are crucial for digital transformation, Woerner et al. (September 15, 2022) identified areas and ten capabilities, which successful digital transformers develop and deploy to create customer excellence and efficient operations that deliver 17.3 percent in revenues and 14.0 percent in net margin, which are above industries. The four areas of the firm comprise customers, operations, and ecosystems, and foundational capabilities, with the latter playing a facilitating role of the other three.

Meanwhile, with respect to capabilities that distinguish leaders in digital transformation from laggards Woerner et al (2022) cite the such factors as delivering customer needs through multiproduct seamless customer experience, having company mission that encourages excellence beyond delivering shareholder value (customer capabilities); developing modular, open and agile digitized services delivered directly as well as through partners, and leveraging technology to innovate, controls costs and accelerate transformation, which supports enhances improvements in processes, data reuse and technology, and capabilities to identify productivity enhancements; develops capabilities to solve customer problems and delivering of seamless customer experiences (operational capabilities); participating in ecosystems that develop and deliver curated digitized products, pursuing dynamic and digital partnerships to extend reach and width of customer-base through automated sharing of data, transactions and insights (Ecosystem capabilities).

In the same vein, in the area of foundational capabilities, digital transformers develop capabilities and processes that support treating data as a strategic asset that is monetizable, standardized,

cleaned, simplified, easily accessible and serves as a vital source of organizational learning that informs decision making, use emerging technologies to develop and retain relevant talent to serve effectively in organization roles while empowering them to solve increasingly complex problems, link individual and team behaviors to goals of the organization by communicating leadership style, and strengthening employee accountability and data, and foster rapid learning in the organization to support adaptability to increasingly uncertain external environment that demand quick adoption, exploration of new ideas, and creating values and scaling up lessons in the organization (Weiner et al. September 15, 2022).

Digitalization, by making financial service delivery mass produced, remotely customizable, and deliverable, has propelled BiTechs, Telcos, and Fintechs into financial service delivery. In the Indonesian context, key players in the digital platforms space include e-commerce and ride hailing platforms that encompass Tokopedia, the largest e-commerce and payments platform in Indonesia and Gojek (ride-hailing platform)²; Shopee, Bukalapak, Lazada, and Blibli (MarketResearch, April 11, 2022); Tiket.com and Traveloka, which are travel booking platforms; LinkAja, an interbank payments network (Medina, April 12, 2022), among others. To that end, thanks to their ability to develop and deploy emerging technologies, aggregate data and glean actionable strategically important insights by leveraging data analytics capabilities to align with customer needs and experiences, new players are offering easily accessible, customized, affordable services that traditional financial institutions find hard to deliver due to various constraints that include legacy systems, regulatory overload, risk aversion and mistaken belief that the new wave of players is just another fad that changing dynamics will eventually push into oblivion.

The reality is that by leveraging data analytics on data on customer needs, experiences and expectations, and internal and external drivers of performance, empowers new entrants in the financial services delivery that include Indonesian post office, Telecommunications companies (Indosat and Telkomsel), e-commerce portals and a spate of Fintechs, to not only gain a foothold in rules based, highly regulated financial services but also carve out niches that make them serious competitors for key sources of non-interest income for traditional banks and possibly incomes of non-bank financial institutions³. It is a development that is replicated in not only other emerging and developing economies but also in developed economies as Data released by Statista testifies. Projections in 2018 showed that of the 55 million people aged above 14 years in US in 2018, 23.4 million would use Starbucks Application to make in-store transaction, 22 million would use Apple Pay, 11.1 million used Google Pay, and 9.9 million would use Samsung Pay (Richter, May 23, 2018).

The entrance of new players in financial services provision while may not be considered to be disruptive or posing an existential threat to traditional financial institutions today, it has the potential to exactly achieve that in the long term. Thus, unless traditional banking institutions adopt and modify the necessary emerging technologies in line with domestic customer needs and regulatory requirements sooner than later, which should enable them to reinvigorate and overhaul their business processes, models and business strategies, they face the danger of being relegated to marginal players in the Industry.

Nonetheless, that is not to imply that the financial services industry has not taken some ground breaking measures to join the fray, albeit in a limited manner. 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. That said, there is little doubt that by deferring the development and deployment of emerging technologies in their business processes and strategies, traditional banks face the danger of losing out to agile new entrants that are not burdened by legacy systems and sunk costs. Thus, while such an attitude is normal and to many has been tried and proved as vital for success in the past, it is highly debatable that such a perspective, outlook and retrospective thinking will not relegate them to becoming perpetual laggards as early adopters and movers seize and concert the rapid and constantly changing dynamics and developments in rules, players, and drivers of success into value-adding business opportunities.

This is the more so considering the fact that central and local governments have not failed to realize and recognize the significant contribution new nimble players in financial service delivery are making toward key policy priority areas including financial inclusion, poverty reduction and income and regional income disparity. Consequently, new regulations are being adopted to create a business environment that fosters accelerated digital transformation through the adoption of emerging technologies. The implication is that any failure for traditional financial institutions to quickly adopt to the new financial regulation paradigm that treats Telcos, Bigtechs and Fintechs as accredited providers of financial services has the potential to increase the influence and control they have over the financial services and products market share in developing and emerging economies. If such a scenario were to be realized, it has the potential to create a formidable and growing threat to the core business of traditional financial institutions, undermine their long term profitability, and by disrupting and upending financial intermediation and monetary policy transmission mechanisms, pose serious risk to future financial stability (FSB, 2020).

That said, one complication is that the new business environment that embraces and is underpinned by emerging technologies in product and business process innovations, requires huge investments in ICT infrastructure and networks, upskilling and reskilling workforce, redefining corporate missions, value propositions and business strategies amidst lingering uncertainties and problems that still plague any hasty adoption of such technologies. To that end, this article assesses the impact of a combination of digitalization, emerging technologies, and new entrants in financial services provision on opportunities, obstacles and challenges traditional banks face in not only remaining competitive but also more importantly avert the creation of new sources of financial system instability in future.

Section two presents the methodology, followed by section three that presents a brief background of the digitalization initiatives in Indonesian banking. Section four examines the impact of ICT on financial services delivery, which is followed section five that discusses BCT, crypto assets and financial services delivery and stability. Section six assesses the impact and ramifications of open banking and financial service delivery and stability, followed by section seven that highlights challenges emerging technologies and changing financial services landscape pose traditional banking, financial institutions in general and financial system stability. The last section draws conclusions to the article.

II. Methods

The article used a qualitative research design, which was implemented using document analysis. The choice of document research or analysis was predicated on various considerations including the focus of existing data sources accessed through creating situations that elicit participants to create such documents as in the case of participant-elicited interviews and those already available from various sources and formats (Grant, 2019); ease of access to various documents using online mediums; flexibility of extending the research scope and coverage from domestic, regional to global context; cost effectiveness as regards time and cost of the research; existing documents provide comprehensive and representative of the wide-ranging and cross-cutting context, and coverage that quality generalizable research demands these days Tight (2019) cited in Koscieljew (2021). Besides, document analysis does not involve creating new data rather either accessing or eliciting available data; applicability to various theories and disciplines (Grant, 2018); considering the fact that most of the data content was in text format, document analysis proved practical and feasible for data collection, and provided an opportunity for data source triangulation (Bowen, 2009).

Document analysis in this research involved examining the purpose and context of the document; reviewed and compared content of every documents relative to other documents; interpreted the results of documents review; collated results obtained from various documents including published statistics, to write the research results, conclusion and policy implications. Documents analyzed

included journal articles, relevant book chapters, laws and regulations, principles and practices, chronicles, circulars, newspapers, reports, relevant YouTube channels content, blogs, podcasts, webinars, digital platforms, and relevant document source applications (Tight, 2019). The main sources of documents and published data included Indonesian central bureau of statistics (BPS), Bank Indonesia (Indonesian central bank), the financial supervisory agency (OJK), International Monetary Fund (IMF), World Bank Group(World Bank), Organization for economic cooperation and development (OECD), Asian Development Bank (ADB), Bank for International settlements (BIS), Financial stability Board (FSB), and relevant Indonesian government agencies. Other key sources included Journal articles, relevant internal and domestic newspaper articles, and relevant laws and regulations.

III. Glance at the Performance of the Indonesian Banking sector

Taking a glance at Indicators of bank performance may provide insights into the state of health and soundness of the sector, and by extension the financial system considering the important role that general banks play in Indonesian economy. Indicators analyzed include trends in total assets, return on assets (ROA) (measures the rate of conversion of assets into net profits), net interest margin (difference between interest income and interest cost of funds), loan to deposit ratio (conversion of deposits into assets (loans), capital adequacy ratio (percentage of risk weighted assets a bank has in place to mitigate any exposure that may arise in future), liquidity ratio (proportion of short term assets in place to meet unexpected liquidity requirements), investment in government bonds (important risk free but low return investment), and operating expenses (measure of efficiency in banking operations).

Bank asset growth

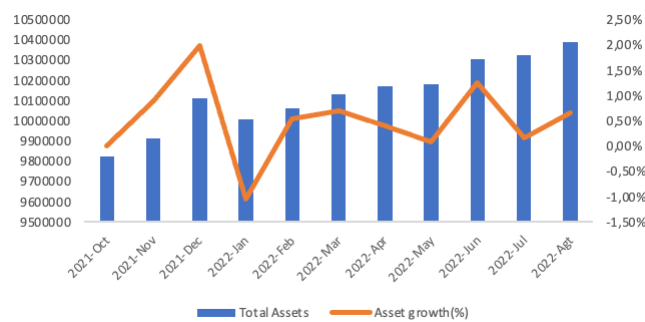


Figure 1.
Source: Indonesia financial supervisory agency (OJK)

Bank assets show an upward trend during October 2021 to August 2022 period. However, growth of assets shows high variability that may underscore inherent risk in bank asset acquisition and management (Figure 1).

Return on Assets and net interest margin

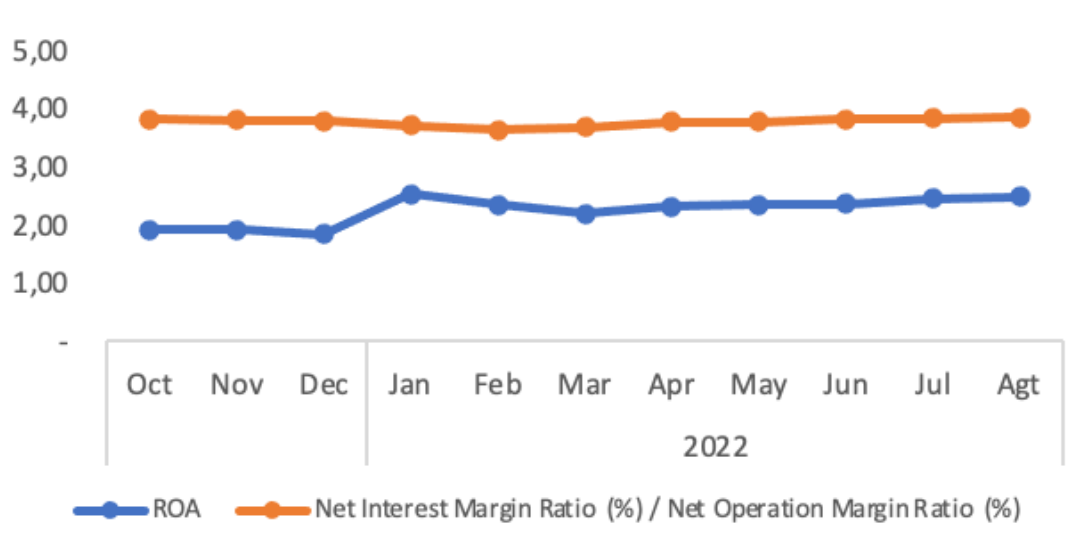


Figure 2. ROA (%) and net interest margin to Net operating margin %
Source: Indonesia financial supervisory agency (OJK)

The performance of general banks as reflected in ROA and net interest margin weighted by net operating margin ratio, remains strong and shows improvement during March-2022 to August 2022

period. The performance reflects an efficient use and source of bank funds (Figure 2).

Core capital, and operating expenses

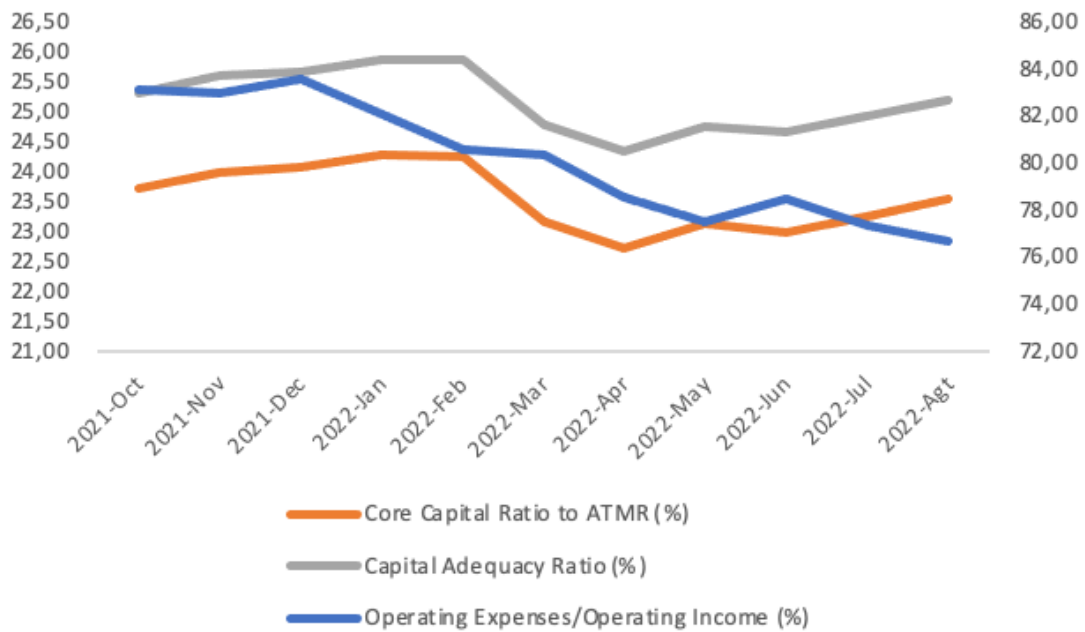


Figure 3. Core capital to risk weighted asset ratio, operating expenses to operating income ratio
 Source: Indonesia financial supervisory agency (OJK)

Despite declining during March -June 2022 period, Capital adequacy ratio and core capital ratio to risk weighted assets ratios remain higher than those recommended under BASEL III. It is important to note that CAR tracks movement in core capital ratio, an indication that banks increase capital buffers as required when they the risk exposure in investments increases. Meanwhile, as regards the trend of the operating expenses to operating income ratio , which is an indicator of the efficiency of use of funds (bank operational efficiency), shows a declining trend, which is in line corroborates improvement in bank efficiency. All such factors attest to a healthy and prudent banking sector (Figure 3).

Bank net profit

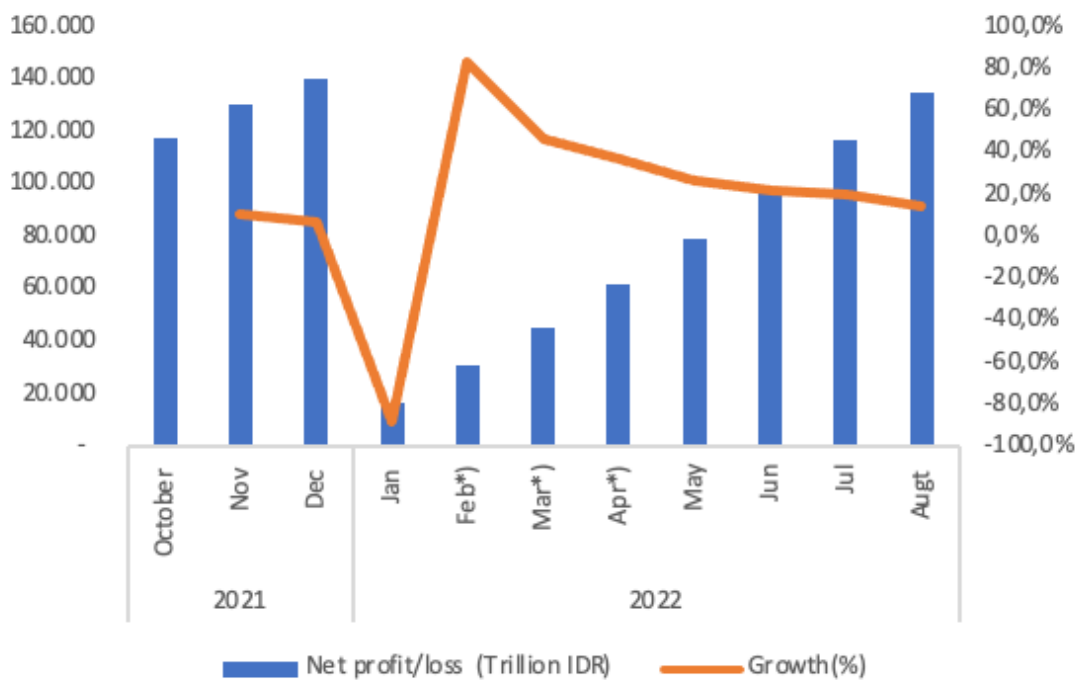


Figure 4. Net profit (Billion IDR) and Net profit Growth (%)
Source: Indonesia financial supervisory agency (OJK)

However, while net profit remains strong, its growth seems to decrease during March 2022-August 2022 period (Figure 4).

Investment in government bonds

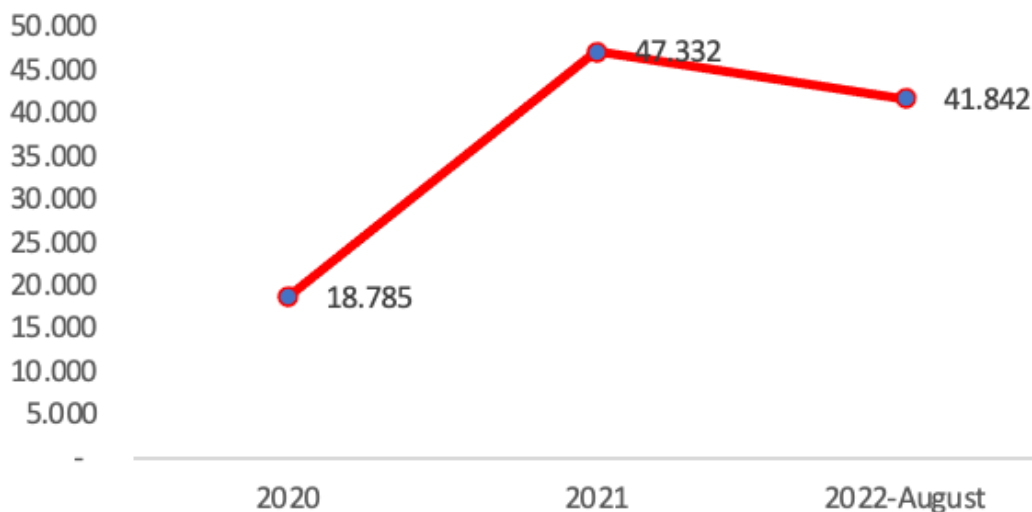


Figure 5. Bank investment in government bonds (SBI and SBIS)
Source: Indonesia financial supervisory agency (OJK)

Investing in SBI and SBIS which are risk free reflects risk aversion, which impacts willingness of banks to disburse credit to sectors and areas considered risky. While government bonds is an important risk free investment albeit low return, increasing investment by banks poses the potential danger that the health of the banking sector, and by extension the financial sector, becomes strongly associated with and influenced by the state of government finances including budget deficit, politics and any other factors that affect public perception of government performance (Figure 5).

Bank capital, bank liquidity and loan to deposit performance

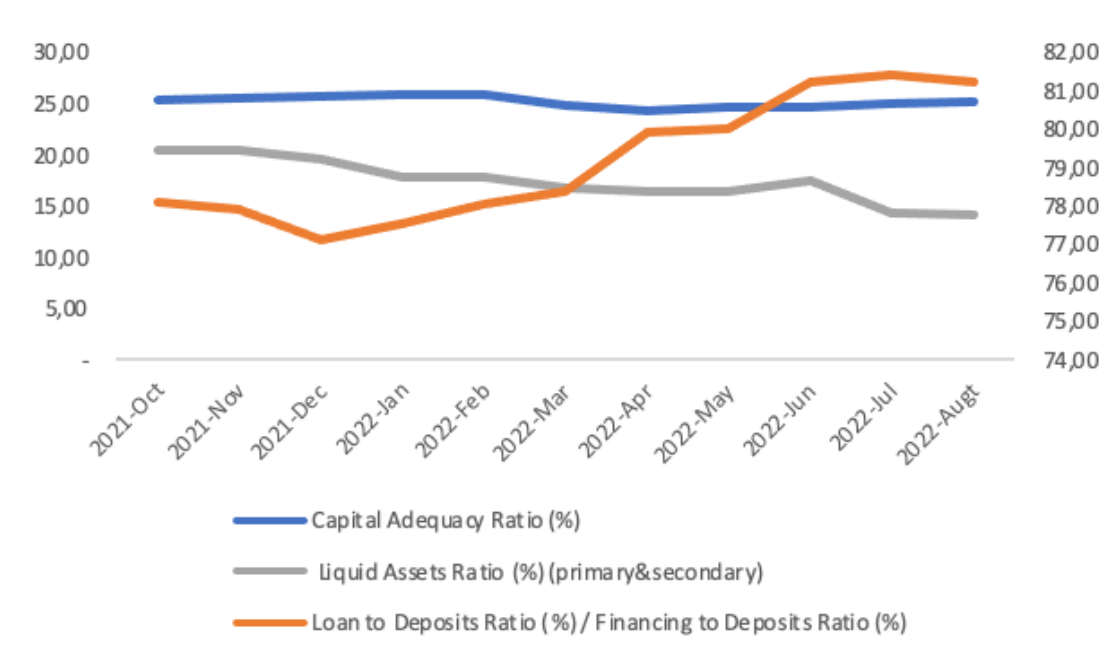


Figure 6. Capital adequacy ratio (%), liquid assets ratio (%), loan to deposit /financing to deposit ratio (%)

Source: Indonesia financial supervisory agency (OJK)

The general banking sector shows strong performance with respect to the capital adequacy ratio (CAR) and loan to deposit to financing to deposit ratio, attesting to incorporating risk management in investment and financing decisions. Nonetheless, the liquidity assets ratio, which in addition to CAR is an important component of BASEL III risk management indicators, while remains still high, shows a downward trend that starts in November 2021 and deepens in July 2022 (Figure 6). Bank liquidity is the first line of defense for not only the banking sector but also importantly, the financial system. To that declining bank liquidity amidst rising liquidity constraints poses potential danger to future financial stability.

It also may indicate that the banking system did not undertake sufficient procyclical liquidity buffers during low interest rate regime as recommended. The tendency to avert to excessive risk aversion under tight monetary policy conditions, may be a strong indicator that despite investing a lot in risk management mechanisms and programs, banks may not be prepared for fundamental changes in key drivers of business competitiveness in the external environment conditions (political, economic, social, environment, and legal) that demand structural and operational overhaul, to institute adaptability and agility in business processes, functions, and internal and external relationships. One of the problems may be attributable to low digital transformation, and by extension, insufficient investment in digitalization and emerging technologies.

IV. Background on Key Initiatives in Indonesian Digital Banking

In pursuit of strengthening equitable development efforts, successive Indonesian governments have implemented various digitalization programs. One such program is expanding financial inclusion through the *Laku pandai* (branchless banking) program. The program allows Indonesian commercial banks to offer financial services through designated agents rather than branches, which reduces overhead costs, expands the reach of financial services to remote areas, hence with national financial inclusion strategy (SNKI). The main goal of the program is to expand the reach and access of banking services to underserved and underbanked sections of the Indonesian population. Thanks to the *Laku pandai* program, general banks are able to deliver services that include saving, lending and micro insurance services through agents and other institutions, by leveraging easily accessible, simpler, and less risky ways⁴ than is the case with conventional financial services provision. This is thanks to the ability of agents to provide basic saving services through a saving account that does away with administration fees, a minimum account balance, and limits on the withdrawal frequency.

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. The program was expected to involve 13 national banks, and recruit 350 000 agents a year (Amianti, March 27, 2015). Thus, despite the requirement that agents can only extend loans after prior approval of the bank under which they operate, major banks in Indonesia have taken advantage of the mode of operations by requesting and obtaining operating licenses to operate branchless banking services from the Financial services supervisory and regulatory agency (OJK). The list includes Bank Mandiri, Bank BRI, Bank BCA, Bank Tabungan Nasional (BTN), and Bank BNI. Consequently, the program has stimulated the expansion of branchless banking services across the Archipelago nation. Based on financial supervisory agency⁵, by September 2019, 25,777,824 accounts had been opened; the number of agents had increased 160,490 to 1,146,131 (614%) from (2016); mobilizing IDR 2.218 trillion in deposits in 511 city and districts in all the 34 provinces of Indonesia.

Another transformational development in digital financial service provision is the development and deployment of Q-code based payment services. Launched in August 17, 2019 through a collaborative arrangement between Bank Indonesia and Indonesian Payments System Association, the quick response Indonesia Standard (QRIS), is a mobile and web browser-based payments system that uses a QR code for all types of payments. What is required is for merchants and service providers to register their personal and business information 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 importantly, however, is that QRIS code facilitates payments that are linked to commercial bank accounts, making it a gamechanger. Moreover, what is making the QRIS innovation widely acceptable in Indonesia is the fact that Bank Indonesia regulation No. 21/18/PADG/2019 mandates all its use for financial payments service providers that use QR in Indonesia. To that end, traditional banks no longer have to develop their separate non-interoperable e-wallets with those of other banks as a way to strengthen their

customer engagement and experience, which does not only reduce 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 was being used in 514 cities and districts, involves 127083 merchants including large, micro and small and medium size enterprises, and facilitated the IDR 382,027,768,637 in payments⁶.

Bank Indonesia-Fast is another nationwide response to the growing need for fast, secure, efficient and real-time, digital payments system that is available 24/7 to meet customer needs everywhere and anywhere. The developed of BI-FAST, as Bank Indonesia emphasizes, is driven by several considerations including strengthening 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 stability⁷.

V. Drivers and Ramifications of Digitalization in Financial services delivery

While banks are projected to register high revenue growth of 11.5-12.5% in 2022 due largely to rising interest margins, which enabled them to post high 14-15% tier I capital ratios, 50% of general banks will continue to generate lower return on equity than the cost of equity. This implies that despite projection US\$345 billion in revenue in 2022, the largest percentage of banks will remain destroyers of equity, perpetuating a problem that has pervaded general banks since the onset of the 2008 global financial crisis (Dietz, et al. 2022). Factors attributable to bank underperformance include long period of low interest rate regime, low long term growth prospects due to legacy systems, rising external environment uncertainty that is reflected in food and energy shocks; repercussions of COVID-19 pandemic on key revenue sources, rising cost of attracting, acquiring and retaining talent, lingering effects of supply chain shocks, and inability for general banks to align their product and service offers with fundamental changes in customer needs, preferences and expectations.

The onset and protraction of the COVID-19 pandemic, has not only created unprecedented global peaceful time death toll, but has also generated substantial damage to core business capabilities, made orthodox business models obsolete if not irrelevant, thrown skill and expert space into turmoil as some highly prized skillsets have become redundant as new ones assume prominence. Besides, the new COVID-19 induced market environment has increased return on value added to providing differentiated customer services, 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.

Besides, the slowly evolving nature of the COVID-19 pandemic and subsequent imposition of restriction on social movements, closure of in-person interaction and imposition of lockdowns on business and community activities, have fostered change in shopping patterns. Consumers either fearing the spread or adhering to health protocols have revisited purchasing patterns from mainly in-person to online channels and increasingly use cashless modes of payments while abandoning cash. Doubtless, such change in consumer behavior has increased the business value and strategic benefits of online service delivery.

To that end, changing consumer behavior in part necessitated by measures aimed at controlling and responding to the pandemic, have created opportunity for providers of services to accelerate digital transformation by implementing drastic changes in business processes, operating procedures, products and services and some are in the process of overhauling their business models. Such a development has been evident in sectors that have been severely affected including education, health, public service delivery, merchandize commerce and financial services (Zou & Cheshmehzang, 2022; Muyanja-Ssenyonga, 2021; Ruzita Abdul-Rahim et al., 2022; Muangmee et al. 2021). That may explain why the impact and ramifications of COVID-19 pandemic (pandemic) have been described as a force that has accelerated the pace of digital transformation (Galvin, et al. 2021; LaBerge, et al. 2020; Goergieva, 2020; Tut, 2021; Vinerean et al. 2022).

Moreover, specifically for the banking industry, the repercussions of COVID-19 pandemic have sent shock waves across management boards as persisting anemic economic growth is has contributed to an increase in risk weighted assets, depreciation of liabilities amidst plummeting liquidity. Consequently, to meet prudential banking requirements, banks are forced to increase asset loss provisions, risk weighted capital and liquidity buffers, and this at a time when they have to contend with declining revenues and profitability on core business activities, and growing need to meet soaring employee attraction and retention costs.

From the customers' standpoint, rising pressures on household incomes attributable to rising cost of basic health care and education services, housing and daily sustenance requirements amidst an increase in uncertainty of employment security, and availability of alternatives that are easily accessible albeit sometimes with hidden costs, are undermining attractiveness of conventional banking services that continue to be not easily customizable, fraught with rigid procedures and prerequisites, unavailable 24/7, and demand a lot of private information disclosure. This coupled with economic uncertainty, has compelled banks to continue to demand premium charges for services at a time when return on customer deposits remains low. Unsurprisingly, a growing percentage of customers especially Generation Z and millennials is opting for using a variety of financial services that are offered by an array of nonbank financial services, which is costing banks vital and stable sources of revenue.

Doubtless, the above conditions are undermining capital formation, reducing bank capital buffers and 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 business activities by shedding off non-core business lines, identifying targets for mergers or acquisition; take measures to reduce the capital hemorrhage by forging strategic partnerships with Fintechs to hasten emerging technology adoption that is crucial for business process reengineering, and product and service innovations (Buehler et al. 2020); and reconfigure 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.

That said, it is important to emphasize that the impact of COVID-19 pandemic has only accentuated a catalogue of existing structural problems banks having facing long before the pandemic occurred. The problems are rooted in the rising cost of developing and delivering services due largely to competition from specialist providers of core bank services that happen to be key revenue sources including third party deposit mobilization, consumption finance, and payments management. Besides, the formidable challenge of rethinking and reimagining bank corporate mission, business strategy and business model made imperative by fundamental technology shifts in drivers of efficiency and effectiveness of business processes; product and service innovations and delivery; an increase in the potential danger from counterparty and operational risk associated with increasing individual and corporate customer interest and investment in highly risky but yet unregulated crypto assets; and challenges of delivering on Environmental, Social and Governance (ESG) expectations (Ditez, et al. 2022), have only compounded the situation.

Redressing such challenges requires reorientating and refocusing corporate capital and resources toward identifying and discovering actionable insights quickly and act upon them to inform business process reengineering, product and service delivery, and product, service and process innovations; and undertake business model reconfiguration to match changes in customer experiences, regulatory regime and competition dynamics. In addition, redressing the problem requires accelerating and scaling new products and services to create first mover advantages; identify,

nurture and forge collaboration opportunities with others in the same industry as well as different industries in the realm of backend and frontend operations technology, sharing in making use of scarce resources as in risk mitigation, as well as keeping track of changes in regulations and standards on product and service offers, employee working conditions, business practices and management compensation packages. Keeping in constant sight and abreast of the varied assortment of internal and external factors, is what it takes for banks to deliver growth during and in aftermath of the next normal economy (Am et al. 2020).

That said, the most immediate challenge traditional banks face today is the rising pace of competition from specialist banks and Fintechs that are using the latest technology and have adopted lean organizational structures to develop and deliver low cost, easily accessible, more convenient, and customized core bank services to differentiated customer segments. Services offered include peer to peer lending services, transaction payments processing, and real-time funds transfer services, which doubtless is gradually eroding vital sources of revenues and income of traditional banks. To that end, the increasing importance of data driven and based Fintechs and Bigtechs, clearly underscores the importance and role that control over customer data, data analytics and relevant technology is playing in shaping the new competition landscape. Needless to note, data analytics is underpinned and informed by digitalization, digital technology and ICT.

However, the increasing importance of ICT and digitization, does not essentially lie in the technology per se, rather the immense contribution it is making toward the development of capabilities to create corporate and economic value through improvements in processes, systems, products and services in general and absorptive capacity in particular (Knowhow). Knowledge capacity in its various forms, has long been recognized as the most important asset a company, society or country has or may acquire. Consequently, economists have long recognized the fallacy of injecting immense capital resources in 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 correlates with 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 increasing 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 to be one of the vital pathways to poverty alleviation due to higher affordability, ease, and simplicity of access to financial services, associated with falling cost of semi-conductors, LCDs, and ICT devices and gadgets, as well as implementation of fair competition regimes in many developing and developed nations alike.

Besides, using ICT has been associated with enhancing 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); and fostering improvement 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 ; increasing market expansion, access, and timeliness of dissemination of accurate information on better prices to sell products, source of emergency warnings that contributes to lower risks from disasters, and increases the 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 non-poor in East Africa with education attainment, living in urban rather rural areas, being determining factors (May et al. 2014); contributes to improving 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).

The digitalization wave is in part attributable to the 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 broad band internet, which factors 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 government and vendors. It is a concept that shows potential benefits if adopted and deployed in social benefit transfer programs through cost reduction, increase in safety and security, convenience of transactions for MasterCard Company in the long term.

Digitalization and ICT in particular have become instrumental in implementing financial inclusion initiatives. This is because 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 of financial services to the poor as well as micro enterprises, is considered pivotal in diversifying the customer base of financial institutions, strengthen micro enterprises, reduce the cost of transactions by increasing cashless transactions, widen bank income sources, widen the reach of monetary policy instruments, hence monetary policy effectiveness.

Meanwhile, the importance of decentralized, digital technology based , secure networks (BCT) is evolving to become one of the most consequential inventions in the digital era. The adoption and deployment of BCT is expected to enable banks to widen the reach of their service offers beyond national and regional boundaries to vitually the entire globe. It also has unlimited opportunities in product development through collaboration, cost cutting on overheads by adopting decentralized ledger system, exchange and transactions through immutable smart contracts, conversion of banks assets into highly secure cypto 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, new set of product offers in the form of cypto 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.

Moreover, using BTC affords players the opportunity to develop 24/7 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 array of product offers, business process, reinvigorate 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.

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 nonfinancial sector 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 digitalization revolution has spurred 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 to 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 by a slew of institutions using non conventional channels and business models. Such institutions run the gamut to include peer to peer (PP) borrowing and lending platforms, data analytics agencies, digital banks that deliver banking services entirely online without physical offices and branches; marketing and trading support service platforms; technological solutions providers that deliver services that bridge financial service providers and trading agencies and brokerages; payments and remittance handling platforms; and Robo-advisors and personal finance services.

In any case, financial technology tools are not limited to retail services but have become crucial to better, efficient, effective, responsive and fraud-free front, middle offices, and back office services (reinventing 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, cloud computing and storage services (Franco et al. 2020:6).

Consequently, one of the sectors that has borne the brunt of transformative digital disruption⁸ (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 2011-2013 period, the number of users of 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 purchase, pre-purchase, and post-purchase decisions, respectively, using mobile or Internet devices (Sengupta, Lam, & Desmet, 2014). Expansion of 4G internet services complemented by the gradual adoption of 5G internet services (especially the non-standalone mode), is contributing to a big leap in expansion in connectivity, which is supporting a rapid increase in internet and mobile use in Asia Pacific (APAC). Thus despite having a lower internet penetration rate than Europe, APAC has the World's largest internet usage by population. Internet usage increased from 2.56 billion in 2021 to 2.6 billion in 2022 (Ganbold, December 12, 2022). In other words, ICT and digitalization have become increasingly unavoidable thanks to the advantages they not only for individual users but also businesses including enhanced connectivity, automation (efficiency), data insights-based decision making, and enhanced innovation capabilities.

To that end, it is not surprising that digitization and attendant digitalization⁹ (digital technologies that shape customer relations, internal processes, and value propositions (Ritter & Pedersen, 2020; Brennen & Kreiss, 2016) has become increasingly important in increasing customer experiences through various forms of service personalization based on demographics, risk tolerance, space, context (emergency or normal), and even emotion state. This is thanks largely to the adoption of financial technology in general and artificial intelligence, in particular, interaction space with customers (front office), vetting customer transactions (middle office), and operations (back offices).

As Business Insider notes, during 2020-2023 period, banks were projected to reduce US\$447 billion in costs through investment in AI technology in the front and middle bank offices (Dgalaki, 2019); and US\$199 billion in costs achieved thanks to investment in AI technology that will help in enhancing customer identification, authentication capabilities, and delivering 24/7 conversational banking services using chatbots and voice assistants to handle transactions, providing insights into customer voice behavior to discern patterns. Besides, the above investments are expected to enable banks to generate timely and personalized services based on customer needs, mood state¹⁰, and experience, all of which will inform decisions on providing personalized, real time and context aligned solutions (Smolaks, 2020).

Meanwhile, another US\$217 billion in cost saving achieved through scaling up investment in AI technology in middle office processes. The outlay is expected 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. During the same period, banks are projected to save US\$31 Billion in costs by investing in back office processes to reduce financial product and service risk by for example strengthening loan covenants through smart contracts (Dgalaki, 2019).

Moreover, digital technology is also expanding the reach of financial inclusion by helping in providing solutions that increase access and affordability of financial services to an estimated 1.7 billion of the World's adult population that remains financially excluded from most of the services (World Bank, 2018). Obviously the lack of access to financial services affecting 21.25 percent of the World's population has serious policy implications for efforts to improve 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 shocks¹¹".

It is not thus surprising that internet and mobile banking services have become an opportunity equalizer to sections of the population who have for 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 Internet in 2017, a figure that rose to 107.2 million in 2019, and is forecast to reach 150 million in 2023 (Statista, 2019). Extension of internet network, coupled with the drastic decline in mobile phone prices, has for many financially excluded Indonesians brought the opportunity enjoy regular financial sciences.

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, 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 formal financial institutions ambit; 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; and increases productive investment and consumption, both of which contribute to economic growth. Besides, financial inclusion has been found to strengthen 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 witnessed an increase in the use of mobile phone sparked by falling prices of mobile phones and internet data packages amidst rapid advancement in Information and communications technology (ICT), internet speed and bandwidth of communications networks and rising computing power of mobile devices.

Moreover, data on financial inclusion, positive a positive association between credit disbursement to small and medium size 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 in previous research that found that widening the diversity of deposit holders reduces 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 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 'lower bottom of financial markets' has generally low institutional risk to lenders owing to the small balances and transaction volumes hence do not pose 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 7).

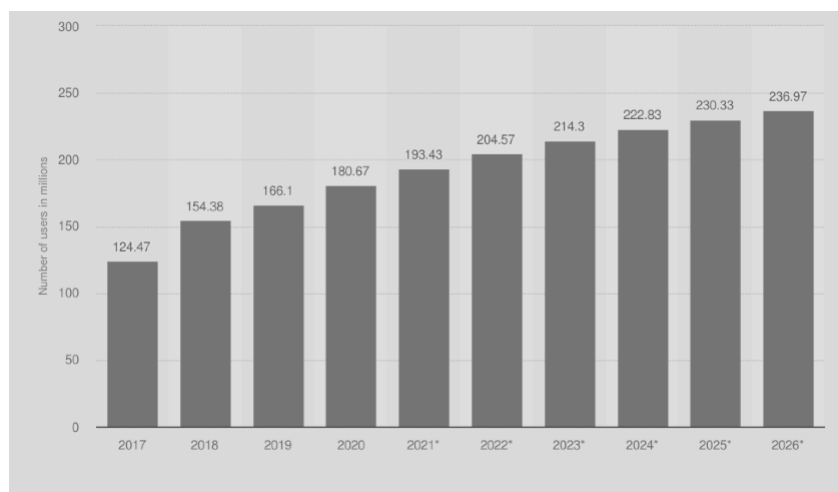


Figure 7. Internet users current and projected in millions (Indonesia)

Source: Nurhayati-Wolff (Aug 16, 2021)

Such developments have led to the perception that mobile phones should serve as a medium that expands outreach of 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, has led to a shift from analog to digital mobile services. It is such a development that has led to an increase in mobile phone subscription. 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 8).

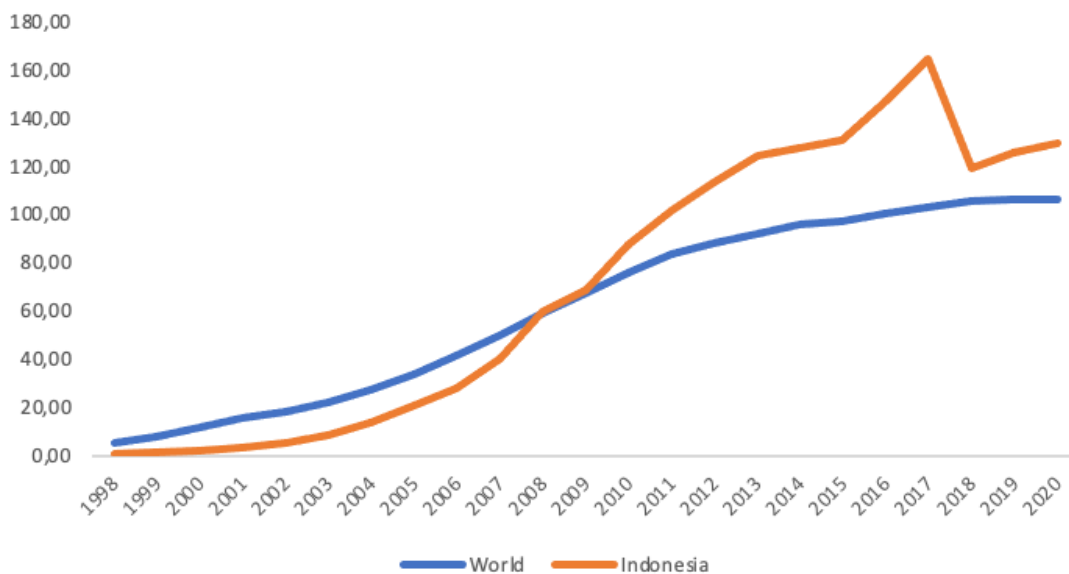


Figure 8. Cellular subscriptions in Indonesia and World, 2020, compared
 Source: World Development Indicators

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 male, 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 adult population) and using mobile phones as a medium to access financial services (50% of all those who have mobile phone and access to internet). It is only 26% of all adult working population (Figure 9) who have mobile phone and have internet access use them as a medium to store money.

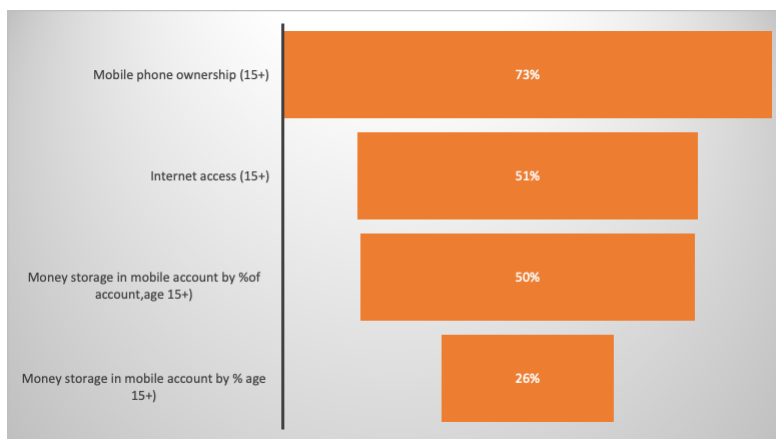


Figure 9. Cellular ownership, internet access and mobile account ownership
 Source: Global Financial Index database (2022)

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 background

have money accounts, only 28 percent of those from poor social income background do so. The gap is also wide based on gender. While 66.17% of adult Indonesian female population have mobile money account, but only 23.22% of their male counterparts do so (Figure 10).

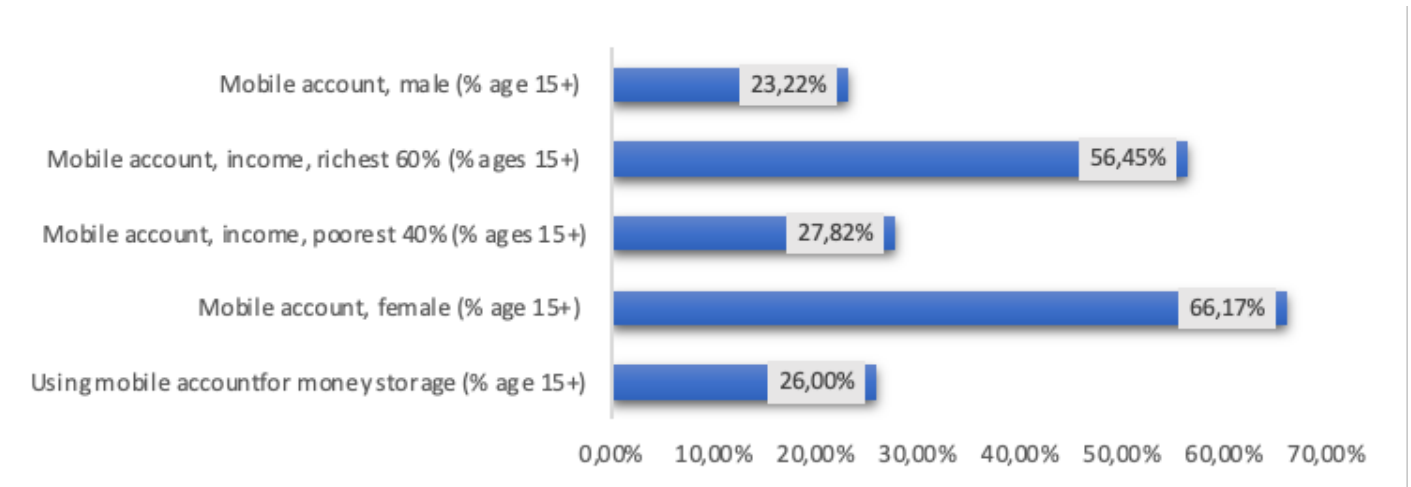


Figure 10. Mobile account ownership by social income status and gender
Source: Global Financial Index database (2022)

To that end, most people who own cellular phones and have access to internet, continue to use them more for social networking purposes than as a medium to access financial services (Figure 11).

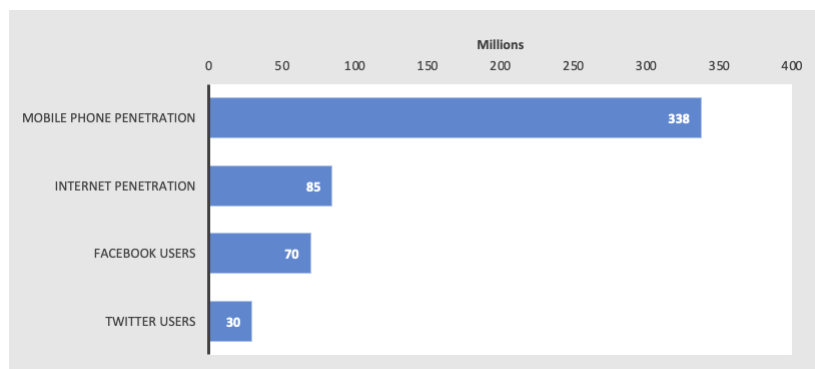
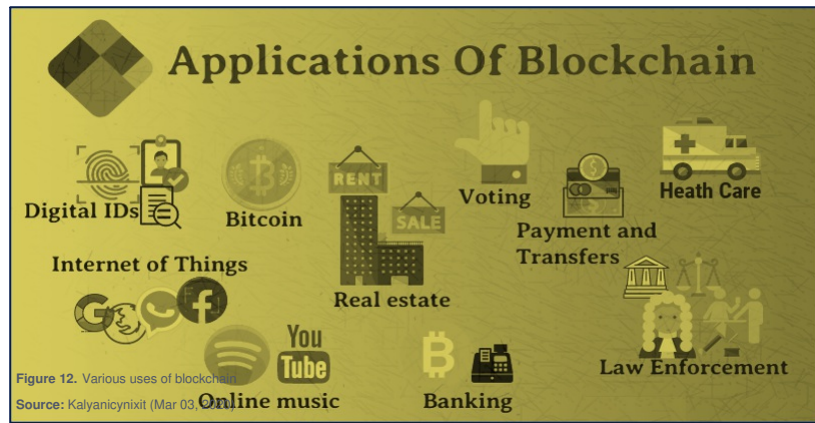


Figure 11. Mobile penetration, Internet penetration, and Social media usage
Source: various sources

VI. BCT, Crypto assets and financial service delivery and stability

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 aptly description of the technology, Crosby et al. (2015) refers to blockchain as "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 consensus of most of the participants in the system. And, once entered, information can never be erased. Despite its current nascent stage, block chain technology (BCT), has the potential to contribute exponentially to global GDP, if projections bear fruition. According to IDBRT (2017) block chain 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."

Based on International Data Corporation (IDC), spending on blockchain is projected to grow at a five-year compound rate of 81.2 percent during 2016-2021 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 US\$9.7 billion in 2021. The business potential of BCT, which by 2030 is projected to reach US\$3.1 trillion in business value-added, is no longer debatable. Several business cases have been tested and proved. The immense but yet unexploited potential of blockchain technology lies in the increase in efficiency of transactions in financial intermediation, healthcare provision, conducting tamper-proof elections, asset management, payment systems, law enforcement, trade and commerce, entertainment industry, social networking, and supply chain management (Figure 12).



Efficiencies BCT is generating arise from lower transaction costs, reduction in intermediation costs thanks to automation of initiating, conducting, approving, and recording transactions all of which replace human labor; decentralized, replicative recording of transactions among all participants on the network. In addition, BCT facilitates major cutbacks in the expenditure enterprises make in accounting and reporting fees paid annually to in-house accountant staff, internal and external auditors; enhanced security, finality of transactions that makes BCT 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. Thus, 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, 2015¹²).

Besides, BCT has immense prospects in the global economy. This is discernible from statistics on the value of capital invested in blockchain startups in 2017 that reached US\$ 1 billion (Carson, 2018). Bitcoin value, which is one of the BCT based applications¹³, was estimated to be US\$800 billion market by the end of 2017, when Bitcoin value was US\$20,000, which was a dramatic surge from US\$20 billion in 2016 (Carson et al., 2018).

In 2017, US\$6.5 billion and more than US\$4 billion Initial Coin offering (ICO) value was made during the first half of 2018 alone. ICO represents tokens that investors buy, which while unlike initial public offerings, do not confer holders any ownership rights to the value of the firm issuing them, are redeemable 'promissory notes' in future in the event the underlying cryptocurrency comes into circulation. ICO, in other words represents one of the speculative aspects of BCT products. This is because ICOs do 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 crypto currencies, drastic decline in crypto exchanges as investors try to run for exit to avert even greater losses, which is contributing significantly to the plummet in prices of nonfungible tokens (NFTs).

However, prior to that development, 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 is 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 veracity an 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 crypto currency against manipulation and theft (Chaparro, August 17, 2018).

Indeed, Bitcoin and other cryptocurrencies (Srivastava, September 24, 2018)¹⁴ have become increasingly circumspect for many in the aftermath of the cryptocurrency exchange hacks, decline in the public confidence of BCT based currencies to become a reliable source of wealth creation (crypto assets), as a secure and vital wealth repository and exchange, driver of firm value augmentation and scaling up, and medium of transactions among various global participants located in far-flung parts of the globe, and the increasingly fluctuating nature¹⁵. Thus, ICO, nonfungible tokens (NFTs) represent just one aspect of the BCT downside, which include among others structural features of the networks that defies centralized control, hence fosters opacity in the transaction process and contract pricing; does not require centralized approval and recording of instances, events (transactions); high vulnerability of online data to cyber-attacks, albeit the strong end to end cryptographic encryption; and high the potential for costly propriety data loss.

Proponents of BCT would argue that the design of the technology is supposed to provide answers to such concerns. Features that have made BCT a vital part of digital transformation in future include decentralized ledger system that is based on an immutable and indelible storage of records; replication of records to all nodes or blocks (reduces the possibility of losing the record in the event one node becomes dysfunctional) (Higginson et al. 2017); distributed ledgers resilient are generally cyber-attack proof (Mullen, 2018); and instances or records once approved cannot be manipulated through modifications, enhances integrity and authority (Henderson, Rogers, & Knoll. 2018; Crosby et al. 2015).

Moreover, every digital event on BCT has its own specific digital footprint on the network with a date and time stamp when it is created, which enables participants to recognize the owner or initiator. Any new digital event to be appended to the blockchain network, needs validation by consensus. The process is not entrusted to all but certain participants (nodes) based on their identities. Identities of participants are embodied in digital certificates that define 'properties'(roles and responsibilities) of actors in the unit in the organization and associated specific tasks, which influence access to resources on the organization blockchain¹⁶).

Blockchain networks are based on a distributed (decentralized) ledger framework, that are of two types, public and private. Private networks allow access only to certain participants hence conditional to being permissioned, an example being Hyperledger DL¹⁷. on the contrary public BCT networks are accessible to anyone (permissionless), Bitcoin is a good example. While Hyperledger is an open source, flexible, and resilient, the need to maintain high trust and confidence in the network, means that only participants (nodes) on the network can conduct transactions but has centralized administrative network of operators to provide oversight. Private BCT networks have centralized control over who joins, does proof of work chores, and therefore contributes to the addition of new block chains on the network.

It thus implies that maintaining some modicum of centralized administration, reduces the potential susceptibility of the network to nefarious activities including cyberattacks, the double spend

problem, and permanent forking problems. Public BCT networks, such as Bitcoin, do not have regulators, which allows anyone to open an account (node) that serves as a medium to conduct transactions (instances) on the network anonymously¹⁸. Thus, anonymity of participants is embedded in the BCT network structure. Nonetheless, overemphasis on anonymity has become a source of vulnerability of public BCT networks to cyber-attacks, making easy conduits for illicit trade including narcotics and ransom seekers and financial fraud (Andriano, 2018). The rising frequency of hacks, some of which have targeted Bitcoin exchanges also raises serious doubt about the veracity of claims of invincibility of BCT networks to such activities (John Mullen, June 21, 2018).

Indeed, past experience tells us that while in the short term and medium term firewalls maybe free from hacking activities that is unlikely to last in the long-term due to advancement in hacking programming, computing power, complacency of legacy systems once impenetrable firewalls are established, advances in computer programming¹⁹ and cyber security applications. Thus, to avoid 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 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. In the latter case, however, 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, initiates a transaction, or registers data on the blockchain."

What is behind strong security and protection of authenticity and integrity of transactions along BCT networks is the smart contracts system. Smart contracts underpin transactions that involve ledgers that are stored in every block or node along the blockchain, make 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 also keeps participants aware of developments in the state of the world of assets in their respective blocks and blocks of other members, depending on ACLs' designations of access along the network²⁰.

Every BCT network participant recognize identities of other participants based on the public key that is attached to the peer or block. This is because the Block contains instances of the ledger and instances of the smart contract. Meanwhile, all BCT network blocks are linked together through end-to-end cryptographically encrypted privacy services, which increases security, trust, and credibility of transactions (Crosby et al.2015). The strong security of blocks, coupled with smart contracts, ACLs, existence of a set of keys for every block, with the public serving as an identification mechanism other BCT participants use to determine and track the source of transactions, makes BCT based participant e-wallets potential for the development of a decentralized customer controlled payments system as the kind that VISA envisages (del Castillo, December 19, 2022).

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 BCT, an effective and efficient anticorruption technology, provided the remaining hurdles that include absence of common standards, consistent and coordinated rules are resolved." BCT-powered decentralized and distributed ledger system is efficient, saves cost, 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 change 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.

On the contrary, traditional business transactions requires that every participant makes records of the same transaction separately, transaction updates take long to be incorporated into the record (as the process follow 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 many accounts of the same record, which increases spending on internal and external auditing services.

Moreover, BCT has been lauded 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 on BCT, it is immutable, and final. Such feature makes it valuable in maintaining integrity and authenticity 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. In any case, not being limited and constrained by geography and topography, BCT has been touted as a vital in reducing the number of intermediaries and cost of interregional and transboundary trade.

Even more important, is the fact that as Carson (2018) cotes is that a BCT can be configured in various ways that align with the requirements and objectives of a single use case, which strengthens flexibility, adaptability and resilience to a variety of uses. Moreover, as a platform that facilitates smart contracts that are executed automatically by computer predetermined conditions that are based on cryptographically tamper-proof encrypted algorithms (Crosby et al.,2015). That maybe the reason why some blockchain practitioners and scientists consider the decentralized ledger system, which is underlie 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 are however doubts that many promises of use cases of BCT may ever materialize, at least not in entirety. The case in point are the problems that self driving cars are facing, which underscores the reality that automation, however invaluable has its limitations. To that end, while BCT has been lauded for its potential impact on financial services and the energy sector, its inherent uncertainty²¹ that is lies in the still nascent nature of the technology, increasing frequency of cybersecurity vulnerabilities, and regulatory ambiguity are influencing the direction it will take. That said, like previous inventions, initial use cases may fail to deliver value, but developments based on failures of such cases informs valuable use cases in future in industry, business, household use and public policy. The growing interest in CBDCs and BCT based business cases, while still at nascent stage underscores that argument (World Energy Council& PWC 2018; The World Bank, 2017).

Indeed, BCT promises a lot of opportunities for banking institutions, that may reduce overheads they face thanks to the reduction of the role of the physical banking infrastructure in determining the authenticity of transactions. That role will be done by a BCT authentication system, simultaneously, in real time, and free from human intervention hence devoid of manipulation and fraud (PWC, 2016). By automating transactions verification, the system should enhance efficiency in cost and time, reduce the impact of human error, reduce operational risk that arises from human errors, and mitigate corporate reputation risk.

Moreover, if there is an element of blockchain that is winning hearts and minds of regulators and banking practitioners alike, it is the super cybersecurity features the technology brings to the industry.²² The value of banking lies in public trust in the institution. BCT network creates an enabling environment that strengthens and supports in-built end-to-end encryption of transactions, business operations and networks, critical infrastructure and assets, which should deter and mitigate fraudulent activities from either internal and external sources.

The replication of all transactions across all nodes of the BCT networks instantaneously obviates the duplication of the same records among different users, which enhances their immutability once they are endorsed in line with the finality principle. That makes transactions tracking easy, which can reduce any possibility of manipulation. To that end, the adoption of BCT as a system, should be advantageous for various 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 on BCT network, reduces the need for a firm to invest in costly database that store transactions, 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 thanks to scaling advantages significantly reduces the cost members pay²³.

Another important feature that has made block chain 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. Designation of participants with authority to approve transactions is based on 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 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.

Based on the atomicity principle, approval and recording of a transaction (instance) on a block chain is dependent on meeting all the predetermined rules that determined and specified hence form integral parts of smart contracts. The principle thus enhances record security, integrity, and authenticity. It is not surprising, therefore, that BCT is considered an 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. Evidence of transaction track record is provided as proof of compliance with supply, distribution and standard issues to regulators and final product and service users.

For banks and other financial service providers, BCT network by providing evidence of transaction track record equips them with both preemptive and mitigating means to detect and handle signs of improper use of their institutions by perpetrators of crimes such as money laundering and fraud. To that end, BCT network provides participants with the means to track transactions right from initiators, intermediaries, to account owners. That way, banks have enhanced capacity to comply with anti-money laundering and fraud regulations, which in turn saves banks billions of US dollars in fines²⁴ they would have paid if found negligent, and many billions more in damaged reputation (London, 2018; EU, May 2018; FSB, May 28, 2019; McLean, July 30, 2019). Concretely, BCT smart contracts framework, protects banks from operational, financial and reputation risk, and by extension non-compliance costs that regulators may impose in the event of proven impropriety and oversight slack.

Recording of transactions on BCT network is based on consensus of blocks. Such a mechanism reduces transaction cost, removes many potential sources of disputes among participants that may arise due to transaction value recording, tampering, denial of involvement, transaction date among others. Doubtless, the array of advantages have lured financial and non-financial companies to arrange transactions that have 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 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, replace existing markets by private markets that are based on blockchain networks, issuing of digitized fiat currency, open, peer to peer blockchain powered economy.

The aforementioned may in part explain, JP Morgan's involvement in designing the prototype of the Project Ubin BCT network with 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 dtltdgers, 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 partners²⁶.

Meanwhile, Deutsche Börse Group has somewhat similar projections with respect to potential use cases of BCT as medium to foster cross border collateral settlement of security assets, post trade processing, including security settlement against cash and assets servicing, and possibility of provision of commercial bank money (cash and assets) on the blockchain to facilitate payments settlement, and assets servicing (Deutsche Börse Group, 2016).

In a similar development, EY (2016) identifies prospects of block chain technology in the realm of health care service data management. The uniformity of record authentication and credentialization, makes block chain technology appropriate for recording, maintaining, and sharing data on health care providers and patients with high degree of accuracy and uniformity during the entire health care provision and claims management process. Supporting features of BCT include immutability of records, foundation for creating a unified provider ID, secure permissioning of health care provider data among service payers during the physician working span, possibility automation of internal control and request processes, efficiency arising from using a single infrastructure network in labor costs, claims handling, adjudication, reconciliation efforts, and improved member experience.

In yet another potential application of BCT, Singapore based Points secured US\$8 million initial funding from various sources including Danhua Capital, Cherubic Ventures, Ce Yuan, Ontology Foundation, Nest.Bio Ventures and Zheng Cheng Xin Credit Technology. The venture leverages BCT to build a credit risk score profiler algorithm that will be trained and tested on credit rating agency sourced data (Zheng Cheng Xin Credit Technology Ltd). Zheng Cheng Xin Credit Technology Ltd is in partnership with Tele info, with Information technology (MIIT) providing Points with 500 million data entries used in developing, training and testing a credit an algorithm tailored towards developing credit risk score profiles (Caiden, July 23, 2018).

In yet another development, IBM, Deutsche Bank, HSBC, Rabobank, conducted a successful experiment that leveraged BCT in transboundary money remittance transaction that involved several countries in Europe. The pilot project 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 was based on an open-source permissioned Hyperledger blockchain.

The success of the experiment proved that BCT technology can generate efficiencies in through conducting cross border transactions through a common platform, interoperability and

connectivity capabilities and collaboration of participants within a trading ecosystem; underscored the potential for even more gains for trade from low transaction costs, real-time transactions trackability, which generate additional value added to all participants (Canellis, 2018).

Meanwhile, the World Bank, as one of the leading development financiers that issues 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, leveraged BCT 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 security²⁷ 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. Doubtless, 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 economy²⁸.

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). In yet another experimental trial conducted on May 14, 2018, HSBC and ING serving as facilitators, used R3 consortium blockchain platform to arrange shipment of US incorporated Cargill's Soybean stocks from Argentina to Malaysia in what has been lauded as first commercial trade finance transaction using BCT. The two transactions above generated transaction cost and time reduction, reduced paper use, hence carbon footprint, while boosting transaction security and integrity in the process (Green, May 14, 2018). On January 22, 2018, a transaction that involved the shipment of Soy beans from 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) was effected.

Other potentially important uses of BCT include Robo-asset management; automation of accounting and auditing functions; foundation of a secure, immutable easily accessible and controllable digital identity that owners can use to do things that demand a lot of trust and confidentiality such as general elections; settling transactions that involve many parties but require trust, such as in real estates business (Andonni, 2018); registration and verification of employers compliance with regulations and laws on employee rights; tracking medicines to counter counterfeits; and as fool and fraud-proof mechanism to monitor the veracity of components of an Internet of Things to prevent nefarious elements from hijacking vital network systems during critical operations²⁹; 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).

To that end, the non-exhaustive summary of business cases above underscores the growing recognition of BCT immense potential. Use cases so far have include bolstering transaction efficiency, authenticity, security and integrity; foundation for decentralized ledger based business models; basis of collaboration in creating innovations, trade, and in conducting regulatory and supervisory activities; trusted repository of priceless digitized assets such as intellectual property, cultural artifacts, among others. General banks, as key players in financial services intermediation, custodians of valuables for corporate and individual customers, and providers of investment and financing advice to customers are well placed to play a pivotal role.

By adopting BCT, general banks are expected to reap hefty benefits including provision of 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; strong immutability of transactions hence lower possibility of fraud, and lower transaction costs. Besides, BCT is also being experimented in reducing financial exclusion, which today affects 1.7 billion people Worldwide. By democratizing and decentralizing financial service delivery through easier access to initial coin offering ICOs for crowd funded initiatives, offering BCT native commodities, and digital securities. BCT is being experimented to deliver 24/7 services to all those with access to BCT. However, the success of the value proposition will depend 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 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.

And this at a time when BCT is still in its infancy and still plagued by lack of common standard that relate 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 secrecy of company data and information in vaults of silos that were only accessible by senior line and C-Suite managers.

Other obstacles include the possibility of double spend scenario whereby some nefarious miners with 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 block chain 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 block chain 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 source 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 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 interoperability³⁰ across Blockchains), increase in scalability (enhancing efficiency in conducting larger volumes of transaction³¹), 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 technology that underlie such assets.

However, the recent plummet in the value of crypto assets including digital currencies³², hacks of exchanges, loss of access to e-wallets and the collapse of crypto currencies 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 crypto currency mining, activity (Karnowski, 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 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).

While it promises many uses, it is still plagued by some challenges that include, absence of a 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 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.

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 evolved, which coupled by 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 the 2018).

Regulatory authorities remain divided, with some considering BCT and crypto currency as an inevitable innovation that financial service will have to adopt due to the slew of advantages it has, while many, fearing losing the control they have enjoyed for long on regulatory oversight, which coupled with bitter past lessons learned about the demerits of 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.

Moreover, crypto currency remains largely 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 system³⁹ 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.

Doubtless, there is 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 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 include "liquidity risk, credit risk, market risk, and 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.

Losses related to crypto asset investment are on the rise. Provisional estimates put the decline in crypto currency to have wiped out US\$2 trillion (del Castillo, December 19, 2022). The collapse of collapse of FTX exchange in November 2022, sparked by poor financial management, which will cost its top 50 creditors US\$3.1 billion and more for its million other creditors is the latest addition to catalog of crypto assets risk saga (Crawley, November 30, 2022). FTX bankruptcy is only the latest in the growing list of troubled cryptocurrency exchanges and crypto currency lenders. FTX's bankruptcy comes not that long after the collapse of the \$60 billion UST coin and Luna token, both of which were TerraForm Labs experiments that were vigorously and previously touted as stable coins. The stability supposedly owed to the movements of the coin being algorithmically pegged one to one to the US\$ (Khalpal & Lee (September 20, 2022) remains as unresolved as it is vivid, underscore the high risk exposure that investors in crypto-assets face.

Thus, while crypto assets investment and financing still constitute a small proportion of assets and liabilities in the financial system, they are gradually becoming a source of material financial risk for non-accredited households, companies, and through counterparty risk, financial institutions and systems. As regards the Indonesian financial system, while Bank Indonesia like other monetary authorities in many developing and developed countries has showed keen interest in developing CBDC (BI, 2022), general banks are still largely barred from dealing in and facilitating crypto asset related transactions due to high uncertainty. Nonetheless the non-banking enterprises do not face such stringent restrictions. As Pratama (2022) argues, at the peak of the COVID-19 pandemic, some investors put their money in crypto currency as one of the ways to mitigate the steep decline in equity prices. That said, considering the precautionary and risk averse stance that Individual banks in Indonesia are accustomed to taking take with respect to new but yet- to-be-tried and proved financial innovations, coupled with micro prudential guidelines on risk management that are integral to the Indonesian Banking law 1998 and implementing regulations and specific Bank Indonesia and OJK regulations adopted since 1997 East Asia crisis, the banking sector does not face high risk exposure from the collapse of crypto assets values.

However, in other jurisdictions such as US where actions of regulatory agencies are limited to calling both financial and nonfinancial institution for caution in dealing with crypto related transactions, not a few have invested in various types of crypto assets including currencies. This includes fiat-referenced stable coins that are estimated to reach US\$161 billion (Andersen, December 19, 2022). Unsurprisingly, the recent tumultuous decline in NFTs and crypto currencies has raised fears of potential financial risk, albeit still limited, to the wider financial system, and by

extension to the economy. Such concerns are reflected in Securities and Exchange Commission (SEC) request to financial institutions to disclose information about their exposure to such assets and liabilities (Kiernan, December 8, 2022).

While the problem is mainly related to unstable, non-fiat referenced digital currencies which makes them very risky as prices are principally influenced by speculation and investor sentiments, fiat-referenced stable coins are not entirely free from risk either. This is because of the high concentration of the share controlled by the three main currencies (90 percent) and ownership of such assets (1 percent of top investors hold 90 percent of the assets). Such high concentration of assets in a few currencies and ownership, poses danger to financial stability in the event either any one or more of asset holders or currencies face problems. Thus, the increase in incidents of e-currency fraud, poor management amidst shadowy operations in unstable digital currencies and rising concentration risk of stable fiat referenced currencies are compelling governments and standard setting agencies (BIS,2022) to take measures that are aimed at classifying crypto-asset trading and investment as posing a potential threat to consumer and financial system security and stability. Indeed, the demand for more stringent regulation of crypto assets has never been louder.

The Bank for international Settlement (BIS) in its June 2022 paper on crypto assets, submitted proposals that envisage the implementation of measures to mitigate risks to banks from crypto assets investments and liabilities. Such measures include classification of crypto assets based on whether or not they meet all classification conditions set out under the current regime; including provisions in Basel supervision committee standards that specifically address crypto assets exposures; refining and elaborating the classification conditions to take into account in the revised classification of high risk non-tokenized and unstable crypto assets; incorporating a risk-weighted assets (RWA) as an additional to the infrastructure risk for all Group 1 crypto assets.

Other proposals relate to the 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).

Meanwhile, FSB on its part, is intensifying efforts to coordinate national authorities and standard setting organizations to reach common understanding on diverse crypto assets risks sources. Besides, efforts are underway to strengthen existing regulations and standards, and where deemed necessary to create new ones that will be specifically tailored to tackling 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).

However, the major challenge lies in the differences in perspectives and approaches central banks in both developing and developed countries have taken toward blockchain technology and crypto assets, especially crypto currencies. There is for instance still no common ground, let alone a commonly agreed standard approach or policy toward crypto assets including digital currencies. In an attempt to tap the benefits of digital currency while minimizing its inherent risks, central banks are seeking ways to, by development and deploying e-currency that remains under their stringent centralized control, direction and regulation.

Rising volumes of crypto currency being created overtime, increases the stakes that in the event of double spend problem there is potential danger of crypto currency dilution, which if materializes poses potential risk to investors and integrity of financial systems. In an attempt to prevent this problem from occurring, among other factors, governments and standard setting organizations have shown keen interest in exploiting the benefits of developing alternatives to unstable digital currencies and assets to become sources of individual and corporate investment- stable digital currencies. Such benefits include lower transaction cost, easier monitoring within and across national borders; higher financial inclusion; faster digital transformation initiatives, trackable monetary policy transmission and collaboration across jurisdictions; and immutable and secure measure and store of assets and exchange.

That said, approaches various central banks have taken toward central bank digital currencies (CBDC³⁴) vary, being driven by functions the proposed CBDC is expected to provide in implementing jurisdictions. Based on IMF latest update on countries at different stages of CBDC development and adoption, 100 national central banks are at various stages of launched, proof of concept, and research (Figure 13).

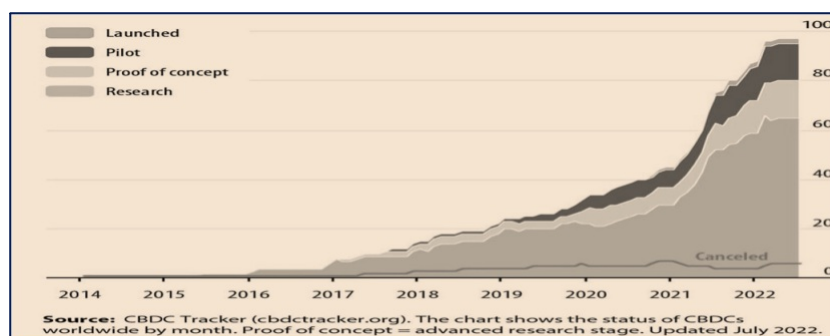


Figure 13. CBDC developments by stage of implementation
Source: IMF (2022)

While the Bahamas, Eastern Caribbean, Jamaica and Nigeria have launched retail CBDC, Senegal and Tunisia and a host of more than 50 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), with 72 central banks having expressed a positive stance about the benefits of CBDC especially in contrast with unbacked crypto coins (December, 2019; Kiff, 2019; Auer et al., 2022; IMF, 2022).

Bank Indonesia, in its Garuda Project report on Digital Rupiah, emphasizes the need to design and disseminate two types of Digital Rupiah: Wholesale Rupiah and retail digital Rupiah. Wholesale digital rupiah will be limited to interbank transactions, while retail digital Rupiah be for general use. The rationale for developing Digital Rupiah include to accelerate digital transformation and development of a digital economy by facilitating and supporting the role digital assets and currency in transaction payments; leverage the benefits of digital finance to support monetary policy; support digital finance development; and increase access to and availability of digital means of payments (Bank Indonesia, 2022). Other expected benefits of stable central bank sponsored digital Rupiah include the acceleration of financial inclusion and innovations; widening sources of storage of value; upholding the mandate of Bank Indonesia as the sole issuer of legal tender under times of increasing digitalization; supporting efforts for Indonesia to become an integral member of the increasingly digital global economy that is supported by stable central bank digital currencies; and

supporting the development and integration of digital economy and finance (Bank Indonesia, 2022).

It is thus clear from the foregoing that being among the late- movers in proposing the form, function and type of CBDC, Indonesia has opted to adopt the design of digital currency that meets both wholesale and retail needs, supports core functions of the central bank, and aligns with other long term policies of Indonesian government such as financial development, financial inclusion and digital transformation. To that end, as the stage of CBDC development is still at its infancy in most key national jurisdictions, the direction of the form that CBDC will take remains uncertain. Such uncertainty increased risk associated with holding and exchanging private sponsored crypto currencies. In any case, the increase in government forays into developments in digital-assets space, is raising fears that national governments may not only limit their endeavors to CBDC development but with the pretext of preventing the perpetration of cybersecurity crimes and financial fraud may also consider it within the remit of public interest to exert control and set the rules of the game for BCT infrastructure development and network in future. The probability of this scenario occurring has increased with the rise of populist governments that aim to maximize unilateral trade³⁵ benefits derived from international trade in goods and services³⁶, and efforts to reign in financial and economic interdependency that are attributable to decades of globalization in production, trade and finance. If such a scenario were to materialize, it will have detrimental effects not only on direct participants but also may roil the financial system and economy (Tapscott & Tapscott, 2016).

VII. Open banking services and financial services delivery and financial system stability

Open banking is based on Application programming interface (API)³⁷ that allows external parties access to integrate, collaborate and share data and services with a bank. API, serves as the technical medium that enables developers to access data and service platforms through protocols to deploy applications that execute on a server elsewhere³⁸. API facilitates the use of programming language, data and services the platform provides, fostering code and functionality customization to align with third party developer needs, imagination and creativity (Andresen, 2007). In other words, APIs are gateways to platforms and in turn, foster access to data, services, and backend IT systems; make possible interactions among systems, code modules, applications and backend IT systems of platform providers, hence, enhance 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, 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, and simplify product and service development of end to end solutions based on modular architecture.

Besides, APIs foster development of consensus on data usage policies, control, access, and performance measurement, leveraging of existing data interfaces in product and application development, which increases efficiency in time and resources and support 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). To that end, 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 made it imperative for companies to adopt APIs to connect their technology assets to online portals and mobile applications.

Moreover, adopting 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 that Baldwin and Clark recommend for a good decomposed network including 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 system³⁹.

Specifically, for banks, they can both publish their APIs to allow partner companies to access their back-end data and technology assets, which provides them with access to and use of external APIs to strengthen their value propositions, and developing new services. Doing that nurtures an ecosystem that connects various units of the company on one hand, and the company with other companies, customers, suppliers, and application developers, on the other. Open banking framework allows third parties access to bank APIs, an arrangement that is grounded in EU PSD2 regulation of 2015 that transferred ownership bank accounts to private persons owing them. That principle in effect opened immense opportunities that are related to ownership of bank accounts in depository institutions (Kellez, et al., 2019; 2021) since banks no longer have exclusive rights the control of customer accounts.

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; Galkowski & Podgajny, 2019). Moreover, the customer can reverse the decision to share data depending on whether preferences and interests are served or otherwise. In other words, the premise that underpins open banking is that sharing customer data should be done in ways that add value and complementary to customer interests, benefits and preferences.

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, 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 customer 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; collaborating 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. Adopting a platform-based model provides most rewards for those companies that develop platforms that redefine value propositions for customers through the strengthening of customer experience by offering better products and services, obtaining more detailed information about product information that enriches user experiences, and social content (Bughin & van Zeebroeck, 2017) forging collaboration with external parties where deemed necessary. Based on Bughin & van Zeebroeck (2017), adopting an offensive (as opposed to either defensive or reactive) platform business model generates 6-7% higher financial than adopters of defensive platform business models (Bughin & van Zeebroeck, 2017).

Thus, the integration of external APIs is being touted as potential enablers of banks to have access to new customers through the enhanced capacity and capabilities to create value thanks to the

ecosystem of sharing information, collaboration in technology, product development, and business process improvement. Partnerships in ecosystem made possible by APIs creates opportunities and capabilities that can be leveraged to enhance product attributes, expand scope of services, deepen customization of services to align with an increased array of customer needs, reduce customer churn, and increase the share of banks in their customers' wallet through upselling and cross selling of services. APIs thus bring the specter of cooperative competition among general banks, Fintechs, Telcos a stage closer to the benefit of all involved parties, but especially traditional banks.

Moreover, banks can derive even more benefits from open banking by developing their own proprietary APIs, which they can leverage to attract third party users including Fintechs at a fee to deliver an increased diversity of financial service offers. That way banks have the opportunity to benefit from 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 open banking regime also create immense opportunities for financial technology companies, which lacking legacy infrastructure of their own to constrain their forays into new financial service offers and markets, 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 serious risk for traditional banks in the long-term, if they fail to take advantage of the potential benefits while they still enjoy high customer trust. A survey of customers surveyed in Poland showed that they have more trust in commercial banks (41%) than technology companies such as (Google (38%) and Facebook (22%). Such high public trust, should allow banks to continue to have privileged access to customer tagged financial data, which they can use to create a variety of innovative products at lower prices that enhance the holistic customer experience (Galkowski & Podgajny, 2019).

One of the potential risks for inaction or playing the waiting game, for traditional financial services was revealed in Galkowski & 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 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 high willingness to trust their transactional data to technology companies that 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 (Galkowski & 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, J Bughin & van Zeebroeck, found that while most large companies were reluctant to adopt API platform driven based model achieved higher financial performance than those that didn't. There are several reasons for the reluctance of banks to develop and publish APIs.

The problem of technology legacy problems complicates platform development because API business model assumes systems integration, interoperability, connectedness, and data sharing across functions and business units, which is contrast to a traditional business model that espouses separability of systems, data, even technology across functions, divisions or business units of the same organization. Moreover, banks have concerns that APIs can open their businesses to competitors. This is compounded by the complexity of outsourcing key services that have for long been in-sourced from third parties, which demands transforming business processes, functions and corporate reporting relationships (Levy, While & Helbekkmo, 2019). Besides, uncertainty about the 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, remains high.

Nonetheless, while traditional banks procrastinate over what steps to take, another even more formidable existential threat is coming from online, lean 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, and 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 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.

Relating to this issue, there is no better example in this regard than Nubank. Established in Sao Pol Brazil in 2013, the digital bank startup is to today (2022) its shares are listed on the New York Stock exchange , has a market cap of US\$41 billion and has so far raised US\$3.9 billion in 14 equity rounds⁴⁰. In 2021, the bank had US\$19.9 billion in assets, US\$1.69 billion in revenue and employees 6068 employees in Brazil, Argentina, Mexico and German. The success of the bank lies in its leveraging digital technology in delivering its services that include credit card that is free of charge and lends credit at below market interest rates, uses mobile phones and website , chats, email, and application to provide 24/7 customer services. This includes requesting for an increase in credit card limit and cancelling a lost credit card (Savchuk, 2019). To strengthen the loyalty of its customers, Nubank has tapped only customer community framework where concerns , ideas, are raised and quick answers are provided. Thanks to the flexibility and adaptability of Nubank's banking model to customer needs the Nubank has 14 million customers and is rated as one of the most valuable startups in Latin America (Savchuk, October 22, 2019). The success of the Nubank's digital bank model in leveraging digital transformation in defining and differentiating customer space, business process, product and service development and delivery, and customer relationships management, has become a model which not only by other bank startups but also traditional banks⁴¹ are replicating with relevant contextual modifications to create and enrich customer value and by extension company value and competitiveness..

VIII. Key Challenges emerging technologies pose to financial service delivery

It is undeniable that adopting emerging technologies is today being recognized as vital for banks to remain competitive which is underpinned by capability and capacity to develop and deliver products and services that meet the increasing demanding needs of today's corporate and household customer, comply with increasingly complex domestic, regional and international regulations, foster corporate culture that supports the development and delivery of value creation, innovative products and services and pivotal for attracting and retaining good talent.

Nonetheless, adopting and deploying emerging technologies may face obstacles from various levels of the organization. One of the potential sources of resistance to change may come from functions and divisions that deem changes a threat to their authority over data and information, organization budget allocation, and attendant perks. This is because digitization by its nature, tends to enhance the pre-eminence of information and technology division in the organization, as it is the function, in addition to the research and development, and 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 competences 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 is 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 the main objective of adopting of emerging technologies is to accelerate digital transformation. Digital transformation performance is influenced by the extent to which an organization reorganizes its structure, functions, relationships, and business process and corporate culture to become data centric. Data centricity organizations to develop, institutionalize and disseminate the value of data collection, aggregation, storage, processing, analysis, and interpretation to glean actionable insights that inform business strategy, policy and practice. Data sources include customer needs, experiences and expectations; scope and diversity of competitor space; and macro drivers of competition including political, economic, social, technological, legal, environmental factors (PESTEL). Obstacles to creating a data centric organization, that include the upfront cost of the supporting technology; resistance from beneficiaries of existing systems and sub systems; legacy systems; and corporate cultural anachronism.

Adopting an ecosystem services-based business model is very invaluable and strategic for companies in financial and non-financial sector alike. This is attributable to the increase in 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. Other benefits include collaborations, partnerships, and procurement arrangements that can be leveraged to generate data and information from customers, suppliers and partners alike, that can be mined for use in advanced data analytics methods to produce actionable insights that serve business strategic interests. Adopting an open banking business model seems imperative, thus, is imperative.

Nonetheless, the risk of entering into working relationships with third parties, which an open banking regime envisages poses 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 important as these maybe today in the aftermath of Facebook⁴² and Cambridge Analytica data scandal⁴³; the implementation of the game changing general data protection directive (GDPR) EU council /EU Parliament Regulation No. 2016/679 on May 25, 2018⁴⁴; 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, which has become common practice on Google search engine, Google Chrome browser, Android operating system, Google play, Google Gmail, google AdWords, Google Maps Google, and Google Analytics (Kelly, August 21, 2018), are surprisingly not the only data security related problems that banks that try to switch and transition from the traditional offline, data-siloed banking model to an open-data sharing in development and delivery of financial services and in conducting operations, face. Hurried adoption of an ecosystem, open banking system while may enhance competitiveness, if poorly executed can create data security problems that may cost banks billions of dollars, lost public trust, and reputation risk.#

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 while 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 plaintiff 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 belongs 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 important 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 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 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 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, deploying⁴⁵, and maintaining the latest digitization technology and tools is another factor. While on paper, 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 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 line(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 being irreversible, maybe extremely costly to not only firm competitiveness but its very survival as a going concern.

The option some banks have chosen is to outsource some of some aspects of their value chain which they consider contributes 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 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 arrangements may use insights they get from data on bank operations and performance to enter the same business on their own.

Besides, outsourcing data and system architecture raises the danger of creating heavy 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. Moreover, another probability is that outsourcing or collaborative arrangements that involve the collection and storage of key performance data have the potential to generate e threats to core business value as suppliers and partners may sell data insights to competitors, or worse still decide to become participants in the industry thanks to the higher competitive edge thanks to, technology capabilities, experience, and insights on key drivers of competition and industry supply and demand.

To mitigate that likelihood, banks can strengthen their 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. In addition, banks should ensure that they retain control over crucial data and system architecture and technology, which is essential for them to develop and deploy data analytics capabilities to discern and gain regular, real-time, and long term insights on customer experiences, drivers of demand for services that are key to improving performance, enter new market segments and develop and deploy new product and service offers (Buia, Heyning & Lander, 2018).

Alternatively, to reduce the possibility of becoming dependent and locked-in on the technology of a single strong supplier, banks should 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 should enable the banks 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 awfully 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 Indonesia⁴⁶ (Suryono et al. 2019), and became a source of substantial loss for borrowers in India⁴⁷ (Thanawala, February 11, 2020).

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 through tightening requirements for opening new platform financial service firms, conduct 24/7 monitoring and supervision of their activities, evaluation of corporate 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 protection⁴⁸ (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 developing 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 bottom line thanks to increased scope, scaling and automation possibilities of the digitization initiative.

Besides, the exponential growth in the adoption of digital technology 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 number or records breached, duration a firm takes to identify the breach, and the time it takes the firm to implement countering measures. 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." Reducing 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 concerns⁴⁹. 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, 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 commodization and modularization of banking operations.

Such a development, while generates benefits through cost reduction, operational flexibility and resilience, opens banks operational systems to third parties snooping with the consequence of generating liabilities and risks that banks must pay, if they occur (BCBS, 2018:5). One good example is the deployment of internet of things (IoT). IoT enhances data and information collection, communication, sharing and transfer in real time, which in turn strengthens 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 institution 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 xcube labs (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; and 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.

In addition, IoT has another advantage which is its contribution to reducing the probability of fraudulent activities thanks to the ability of transmitting particulars of the customer through immutably encrypted messages; supporting 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 insights on vehicle usage pattern, driving habits, condition of vehicle parts, incidents and so on that are transmitted by on-board IoT devices to banks, insurance companies and vendors), which lowers possibility of fraudulent claims, reduces maintenance cost, repair claims assessment costs, thereby increasing efficiency and value added.

With the support of augmented reality (AR), repairs are affected 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 account with devices retrofitted with sensors in the customer's home that need regular refilling (such as refrigerators), and by using artificial intelligence empowered devices that can send purchasing orders through remote voice commands (Amazon's Echo and Alexa, and Google's Home).

Nonetheless, while its benefits seem limitless, the dangers of IoT cannot be underestimated. Worth noting is the vulnerability of IoT devices 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 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 cost of funds as customers choose other investment alternatives. Inevitably, lesser third-party deposits and borrowing from the banking systems, weakens 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 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 the public, private and hybrid Cloud facilities and BCT 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 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 fully-fledged 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 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, 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 (Minister of finance had proposed 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 account. 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 easy 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 the art technology that exploit 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 an authoritarian regime wants to repress 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 message, issue an instruction 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 a 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 may 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 without seeking consent of the account owner first, it is not plausible 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 of 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 banks 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 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; 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 of customers of mobile and platform money market accounts losing access to their savings is very serious cause for concern. Similarly, the rising restiveness in peer to peer (PP) lending and borrowing platforms due to complaints of extortive interest terms, the malpractice of unilaterally changing covenants at will, and use of debt collectors in pursuing repayments (Cahyani, 2018), constitute elements on a long laundry list on problems that users of seemingly online platforms are facing 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 various counterparty relationships.

Inevitably, that makes financial tech performance a new frontier for financial system supervisors and regulators, which thus, adds another veneer of complexity to the immense responsibilities for regulators and supervisors to keep a daily, 24/7, watchful eye. Doubtless, the plethora of problems has emerged as a result of 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 is the failure of financial sector regulatory authorities to oblige providers of web platforms and mobile based financial services to establish governance structures in a timely manner, which if effected, 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, fundamentals of 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.

It is worth noting, though, that implementing emerging technologies is not possible without embedded AI. Manifestations of AI are increasingly evident in automation programs of product development efforts, business process improvements and reorientation, customer experience and loyalty enhancement, data analytics, cyber security and corporate asset protection. There is little doubt that the rolling out of 5G wireless broadband internet, either the non-standalone or standalone (Rami, 2022; Otto, July 13,2022) will accelerate the pace of emerging technology adoption and deployment because it is today an integral component of digital transformation.

This is because 5G implementation supports digital transformation, including API open banking services, ecosystem framework services that are integral to business model transformation, embedded finance, deep learning, among others. This is because 5G offers better quality connectivity, speed, security that respond to increasingly various demand for multimedia media content and services and data. This is attributable to various features and factors. 5G wireless internet has faster speed that supports enhanced mobile broadband (eMBB) that leverages cloud edge computing capabilities, which makes data processing in local networks close to points of usage possible; delivers ultra-low latency communication (ULLRC) or mission critical machine-type type communication (eMTC); bi-directional large bandwidth shaping capabilities that support massive machine-type communications (mMTC) or massive IoT services; and supports the addition of functions through software updates (virtualization); and operating of several virtual networks for differences needs that reduces expenditure on capital investment and operating costs.

Overall, 5G provides better quality internet experience due to its ability to use different radio frequency bands (ranging from low, mid to high) that support different capacities, uses and coverage. There are two types of 5G are currently available for users. The super fast 5G uses radio frequency bands that range between 24Ghz/s -40Ghz (mmWave). The major weakness of mmWave 5G lies in its limited coverage range as access is affected by distance from transmitters, presence of windows, trees making it confined to dense, urban areas and locations (some of the above weaknesses are being addressed by technology advancements including multiple input multiple output (MIMO) antenna arrays, massive MIMO (mMIMO), and beamforming antennas, among others (Rami, 2022)). Meanwhile the sub 6G, which is more widely available, uses radio frequency bands that range from low (from below to 1GHz) to mid-bands (3.4GHz to 6GHz). The advantages include longer coverage range as it is not affected by distance from transmitter, physical obstructions, windows and trees (Clover, May 9, 2023). In addition, 5G's antennae innovations enhance signal concentration improving spectral efficiency and data capacity, that in turn minimizes interference arising from simultaneous access by multiple users (Rami, 2022).

Nonetheless, ensuring flawless, regulation-compliant, and socially-acceptable implementation of emerging technologies will demand addressing several issues that relate to artificial intelligence (AI). AI is embedded in emerging technologies, yet it there are concerns about potential risks. Among such risks are biases against minorities that are subconsciously built into algorithms during model training, fine-tuning and optimization; accessing and using customer and corporate data without consent, raising data privacy infringement disputes; that can triggering massive layoffs that may undermine public trust and perception of banks as agents of social and economic sustainability; leveraging technology to maximize benefits of product and service differentiation by segmenting customers along similarities of social groups based on race, socioeconomic statuses, religious and political affiliations. Such a practice if automated, has the potential to accentuate social chasms and polarization.

However, there is a strong and naïve assumption that banks can have it their way to adopt and deploy current and future drivers of competition, including emerging technologies, without the intervention of financial regulatory agencies. That just cannot happen considering the fact that the importance of general banks in supporting economic growth and stability due to the vital role they play in financial intermediation, monetary policy transmission, fiscal policy implementation, financial development, public financial security and financial system stability, general banks are some of the stringently regulated institutions. Having the readiness, willingness, and interest to adopt and deploy emerging technology may not be sufficient for banks to implement request policies in that regard. This is compounded by the retrospective, if conservative nature of regulations that guide investment, financing and transactions involving financial product innovations and business processes.

IX. Conclusion and Policy Implications

The thrust of this article is the impact that Block Chain Technology (BCT), open banking and Fintechs, Bigtechs and Telcos on operations and performance of general banks and financial system 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.

Internet, 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 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 is also vital for bank sector and financial system health. BCT and benefits that are associated with its enhanced cyber security, decentralized authentication, increased operational efficiency, low compliance cost, shorter onboarding rates of new product and services offers, 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 process improvement, reinvigorated business models, that should contribute significantly to efficiency and profitability of financial intermediation and monetary policy transmission, and by extension, financial system 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 level of excess reserves general banks hold in central banks on liquidity in the financial system.

Meanwhile, with respect to open banking, potential risks are likely to arise from the 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 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 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.

While risky and requires costly huge upfront and recurrent investment in infrastructure, business process changes, talent recruitment, reskilling and upskilling, and organizational structure and culture reorientation, reorganization, restructuring and even repurposing, returns on the investment in adoption and deployment of emerging technologies isn't uncertain as long as the process adheres to best practices. Considering the many strategic benefits and leverage banks can derive from emerging technologies capabilities, specifically digital transformation, investing and deploying the related asset, infrastructure and technology is no longer an option but an imperative to future proof bank performance.

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 digitalization ecosystem through a multipronged approach, including revamping backend and frontend technology, gradually tweaking, rejuvenating and where necessary abandon conventional banking business models, strengthening collaboration in product and service delivery and attendant technology, discarding the bank is king and adopting the customer-centricism is the only source of sustainable value mantra. Not doing that increases the possibility that in ten years or less, banks will be reminiscing about lost opportunities due to failure to leverage 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.

Worth noting however, is that technology adoption is important because of its contribution to corporate value, rather than for its sake. Thus, the adoption of emerging technologies should be integral to efforts to increase the ability and capabilities of banks to compete in the digital economy. Data analytics has become the driver of competition in not only banking but also in all industries and sectors since it is underpinned by digitization and digitalization. Thus, to remain competitive, banks must deploy emerging technologies in key areas that strengthen their capacity and capabilities to collect, store, curate, transform, analyze, interpret customer, supplier, competitor, and policy insights to inform business strategy. Doing so should help in the reengineering of business processes, decoupling loss making non-core financial services to focus on key revenue activities which are facing serious competition from technology companies and Fintechs (deposit mobilization, payments management and lending and borrowing, and insurance services. At the end of it all, however, adopting emerging technologies will only create sustainable value if adopters develop capabilities to monetize the benefits and advantages in ways that align seamlessly with changing customer behavior. This is where embedded finance plays a pivotal role.

Embedded financial service provision is another area where Fintechs and technology companies are outcompeting traditional banks. Embedded finance involves the integration of payments, lending, investing, insurance, and banking services into application, create one-stop service interface for customers. To that end, users of embedded finance cite convenience, ease of making payments, aversion of cash payments, investments and trading, borrowing and lending, and seamless integrated insurance services. The attractiveness and rising demand for embedded finance, accelerated in part by the policy response and customer behavior change triggered by the Covid-19 pandemic, has created demand for embedded financial technology platforms. Consequently, the supply of platforms offering embedded financial services has increased, a development to which funding sources have shown strong positive response at the domestic, regional and global levels.

In ASEAN alone, financial technology including embedded finance, attracted US\$4.3 billion in funding during January-September 2022, a figure that represents an increase of more than 200 percent of the comminated value for 2018-2020 period and 7 percent of US\$63.5 billion invested globally in Fintechs during the period. ASEAN remains attractive for FinTech investments (UOB,

PwC Singapore, & SFA,2022). The increase in investment in Fintechs, is supported by efforts to lay the requisite regulatory framework. In Indonesia for instance, the UOB, PwC Singapore, & SFA report cites the role that improvement in the enabling environment as reflected in the completion of the licensing process of 102 PP lending platforms by OJK in January 2022, and the recognition of digital banking as a subcategory of commercial banks in Indonesia has contributed to making the country a fintech powerhouse. Thus, it is not surprising that Indonesia received US\$1.4 billion, which represented 25 percent of FinTech funding in ASEAN, which placed the country in second position in the region, while Singapore with US\$1.8 billion, representing 43 percent of the funding was in prime position. Fintechs offering embedded finance, especially payments get-ways, received the largest share of funding.

Thus, embedded finance is an area where traditional banks can invest some of their capital and human resources in emerging technologies to increase their capacity, capabilities, coverage and reach, either through spinning off branches, partnering with independent Fintechs, or creating new digital banks through collaborative arrangements among banks, Fintechs, Bigtechs and Telcos. Moreover, since customer relationships management is crucial to attracting and retaining customer loyalty, it is also an area where the deployment of emerging technologies can play a crucial role in establishing new footprints as well as strengthening existing bank footprint. Emerging technologies can be used to leverage banks experience and knowledge of customers to offer subscription services that should help to increase the diversity of revenue sources.

Underpinning organizational resilience and agility , is the extent to which management and employees feel secure and safe to engage, propose and get involved in suggesting new ways of doing old things , new changes to routines, and new concepts to improve existing product and service offers as well as entirely new untried products and services. This is what encapsulates a learning entrepreneurial organizational culture. Innovations and inventions can be bought but sustaining their contribution to organizational value creation requires nurturing and supporting an entrepreneurial organizational culture. The same applies to the adoption and deployment of emerging technologies.

Considering the urgency of the need to change and the reality that regulation renewal often lags innovations in competition and business processes and practices, the starting point of the process should be revising, if not overhauling, provisions in prevailing laws and regulations, standards, recommended principles and practices. This is because while most regulatory frameworks, standards and protocols that undergird bank financial health today were adequate in enabling banks to develop relevant capacities and capabilities to face the old types of risks , they are definitely ill-prepared , structurally, institutionally, orientation, scope and coverage, to serve the purpose as well as they should in the current environment. Effecting regulatory regime changes should help to accelerate the alignment of bank strategies, processes and practices with the rapidly changing technologies that are transforming business processes, and product and services. Changing technology spurs innovations in products, inputs, processes, and practices, which need revised standards, operational principles, protocols and practices. And that time is now.

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Notes

1. Defined as stored codes that are only accessible electronically (Narian & Moretti, 2022)
2. the two companies merged in 2021 to create GoTo , which today has a market capitalization of US\$32 billion (Medina, April 12,2022)
3. This includes remittances, money transfer, payroll payments management, and others that are based on insights about customer experiences, needs, lifestyles and networking patterns and relationships .
4. LakuPandai agents have better knowledge of their customers than traditional bank branch officials because they live in the communities where they serve. This obviates the need for high loan to value ratios, if any, collateral security and demand for a lot of intrusive customer private information
5. <https://www.ojk.go.id/id/pages/Laku-Pandai.aspx>
6. <https://gris.id/homepage/>
7. <https://www.bi.go.id/id/fungsi-utama/sistem-pembayaran/ritel/infrastruktur/default.aspx>
8. 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
9. 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)
10. In a blog on benefits of artificial intelligence in banking,[Smolaks\(2020\)](#) 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.
11. World Bank(2018)
12. Deep shift: Technology tipping points and societal impact, World Economic Forum, September 2015, weforum.org.
13. 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).
14. 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
 15. From a price of above \$65, 000 in early December 2021 Bitcoin price has plummeted to \$17,000 per unit in early December 2022, attests to the high volatility of the price and by extension absence of fundamental anchors of the currency. Touted as protection against secular inflation due to the maximum of quantity that will ever be in supply (21,000,000), the reality demonstrates that Bitcoin price is actually tracking general performance of the economy, rather than a shield against economic shocks including inflation, as originally thought (Locke, May 07, 2022).
 16. <http://hyperledger-fabric.readthedocs.io/en/latest/identity/identity.html>
 17. <https://www.hyperledger.org/>
 18. 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 1 millions of Bitcoin (valued at US\$ 9 billion by May 2017), was stolen from a number of exchanges.
 19. 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)
 20. http://hyperledger-fabric.readthedocs.io/en/latest/build_network.html
 21. 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 cyprtcurrency 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.
 22. <http://hyperledger-fabric.readthedocs.io/en/latest/identity/identity.html>
 23. 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
 24. 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).
 25. 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
 26. <https://www.dlt.sg/about-us/>
 27. 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
 28. *ibid*
 29. during a remotely executed surgery involving many IoT components spanning long distances and using many internet connections provided by equally many providers
 30. 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).
 31. 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>).
 32. 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).
 33. 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(Decembre, August 20, 2019)
34. 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 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)
 35. Undoubtedly this is contrary to principles and drivers of globalization that are based on national and regional comparative and competitive advantages
 36. Trump's America was a very a good example
 37. API Strategy 101: What is an API? <http://www.apiacademy.co/resources/api-strategy-lesson-101-what-is-an-api/>
 38. 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
 39. <http://platformed.info/apis-platforms-how-interfaces-access-enable-networked-economy/>
 40. https://www.crunchbase.com/organization/nubank/company_financials
 41. <https://nubank.com.br/en/>
 42. 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).
 43. The scandal involved the misuse of personal data for 80 million Facebook users
 44. 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
 45. 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.
 46. 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
 47. The rising renegade activities among other measures, motivated the Reserve Bank of India 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 amount they cannot repay leading to bankruptcy of lending platforms (Klein et al. 2021)
 48. 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)
 49. 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](https://www.singapore.gov.sg/press-releases/2018/07/21/20180721-01), 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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