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BLOCKCHAIN TECHNOLOGIES BEYOND A FINTECH TREND - THE DIVERSIFICATION TO NEW PARADIGM

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Abstract: Blockchain technology is one of the disruptive technologies of the current decade. It's rapid development and acceptability across every walk of life pervades industries and public domain alike. The most appealing feature of blockchain technology is its data immutability, data distribution, and simultaneous data availability to intended users, which allows freedom from an old-fashioned client-server mode of communication.

This paper details blockchain developments across the globe through the underlying distributed ledger technology (DLT) by shedding light on adoption and viability of DLT models by analyzing various use cases to fetch the abstract features and usability of blockchain technology in the capital market for various stakeholders of the capital market. Since this research work is focused on the financial domain and the target audience would be from the non-technical background, it is inevitable to incorporate the fundament idea, necessary infrastructure, and applications of blockchain technology in the capital market. TIt will also highlight the pros and cons of implementing the technology and the areas/research issues which are to be addressed. It is expected that regulated use of this technology will simplify transaction processing/recording/control in a cost-effective manner with improved throughput and scalability. This research is also trying to look out the current development and future plans of major stock exchanges on the course of this technological transformation and why these stock exchanges considering blockchain as a technology of future for the capital market. Despite current technological and regulatory challenges of blockchain technology, active involvement of major stock exchanges in developing and adopting blockchain technology to obviate shortcomings of existing client-server architecture successfully demonstrates the outlook about the future prospects of this technology. The research comprises various compilations and analysis of different sources issues/reports from market players, government organizations, and researchers regarding benefits and the adoption of this technology. The research is mainly qualitative research, and a purposive or judgmental sampling has been used. The overall theme running across this work is to analyze the impact, usability, and feasibility of DLT adoption in the stock market.

Keywords: Blockchain Technology, DLT, Capital Market, Trading, Clearing and Settlement, KYC, AML

Introduction

In today's world of financial and information technology sector "Blockchain" has become an elusive yet compelling terminology and professionals related to these sectors trying to comprehend, decipher, and tap the enormous potential of blockchain to revolutionize the existing financial and nonfinancial sectors in an unprecedented manner. The key objective is to develop a technology to create a single source of trusted information that opens new possibilities in conducting business.

Firstly, the purpose of working on this research topic "Blockchain Technologies Beyond a Fintech Trend-The Diversification to New Paradigm" is to explain myriad possibilities of blockchain development to facilitate different spheres of market across the globe, by harnessing the unique features of distributed ledger technology, which is the driving force of blockchain architecture and enabling it as technology of the future. Secondly, by analyzing various academic and industry reports, trying to correlate advantageous features of blockchain technology for capital markets such as major stock exchanges, its acceptance, and prospects of blockchain technology in this market segment.

Since financial services of the capital market and other financial institutions are underperforming due to inefficient capital utilization, lacking uniformity, high cost, inconsistent risk compliance, and poor customer experience forcing to investigate and adopt blockchain technology for betterment in every aspect.

Some of the key issues capital markets have been facing today are listed below, and during the course of this study, they will be evaluated as to how they can harness the potential of Blockchain technologies.

- Manual, inefficient process:
    - Trade settlements are lengthy because details are recorded separately by parties and post-trade reconciliations are complex and prone to errors
    - Limited transparency due to multiple parties and paper-based processes
- Time-consuming and costly
    - Checking, authentication, and authorization – On individual as well as Government levels
    - Identity authentication required for proof of entitlement and transaction processing
- Access to capital is costly and difficult
    - A large number of intermediaries in the process, leading to huge procedural requirements
    - The scale required to utilize available capital raising option

Distributed Database: A database that is stored on multiple devices and nodes. All the nodes are assumed, to be honest, they cooperate on account of mutual trust.

Distributed Ledger: Is an expanding list of cryptographically signed, irrevocable transactional records shared by all participants in a network. With this information, anyone with access rights can, at any point in its history, trace back a transactional event belonging to any participant. The central premise is that individual nodes do not trust their peers.

Blockchain: Is a chronologically ordered type of Distributed Ledger Technology (DLT) in which transactions/records are structured in a chain of blocks. Each record contains a timestamp and reference links to the previous transactions or exchange of data occurred in the network.

As illustrated above, the entire Blockchain technology infrastructure is a product of high level of encryption (Public Key – Private Key cryptography) and distributed data storage (peer-to-peer) that provides an upshot in the form of resultant data available simultaneously as centralized system on the logical ground and technically disseminated at every node of network concurrently. To maintain the same 'view' of same 'data' for all nodes regardless varied physical sources of data retrieval, network uses a single authoritative and irreversible ledger of all the data transactions from the origin of the data structure (Mainelli, 2015).

The key merits of Blockchain technology are driven by two propositions. First, cryptography, encryption, distributed character, and immutability. Second, Permissioned Blockchains for selected participants with controlled access to maintain the transaction ledger.

Blockchain as Growth Driver of Next Industrial Revolution

In late 2000s blockchain technology came into the picture with the advent of first crypto-currency bitcoin to obviate the role of intermediaries, since that time blockchain technology has been considered as a potential alternative of a centralized database system. For the last couple of years, governments and several industries have been investing in the research and development on blockchain technology in order to eliminate current hurdles of traditional financial activities and achieve and more efficient digitized economic infrastructure in next few years.

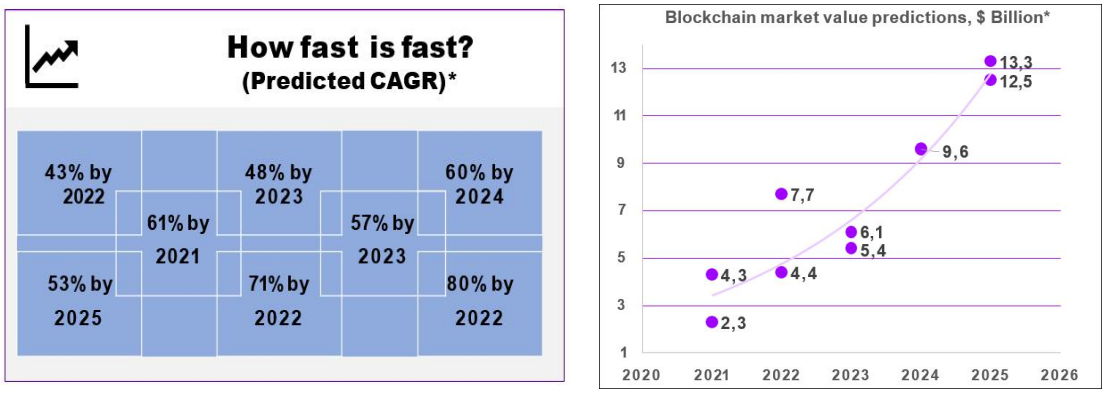

Figure 2: Growth in the Blockchain Market
Sources: Market Reports World EstiCast Research & Consulting Research And Markets
Yahoo ASD Reports Statista Allied Market Research

There is no single, unquestionable number that would define the DLT/Blockchain market size. However, it can be assessed based on the number of platforms, startups, and various value estimates. The global market for blockchain was valued at $708 million, and a recent blockchain report from Market Reports Center is forecasting the market size to reach $60.7 billion in 2024 (www.globenewswire.com). The demand for blockchain technology is growing everywhere and big market players like IBM, Accenture,

Microsoft, etc. are seeing blockchain as the top application driving growth. They are working with governments, financial institutions, and other industries to move into an era of real-time transaction processing, new ways of cross-border transactions, government data management (www.globenewswire.com). In a nutshell, almost in every sector where digitization exists, there will be the possibility of blockchain applications.

The reason behind capturing immense attention of blockchain technology is its distributed nature and ability to eliminate the shortcomings of the client-server technology, such as venerable security, the centralized system, lack of transparency, and data integrity issues, by providing immutable data storage, cost-effective infrastructure, and distributed accessibility (Crofts et al., 2018). In the context of the capital market such as stock exchanges and other financial institutions suffers in performing crucial procedures like post-trade clearing and settlement, maintenance of customers' data, handling contracts among parties in digital form, causes massive time lag and enormous cost overhead. Another setback of centralized system form customers' standpoint is the privacy of customer's personal data and integrity of the transaction cycle. The Deloitte Australian Privacy Index 2016 consumer survey shows that 94% of consumers believe trust is more important than convenience. Similarly, 67% of respondents concerned when organizations send their personal information outside of Australia (Deloitte, 2016).

Despite such as a meteoric rise in Proof of Concept exercises and commercial implementations, researchers see the technology as an adolescent and not ready to become mainstream as yet. Notwithstanding its enormous potential and possibilities, Blockchain technology is grappling with many challenges such as time lag in the verification of transactions, un-estimated cost expenditure of transition process from centralized technology to distributed technology infrastructure, and lack of framework and legal precedents, with multiple jurisdictions to coordinate which hampering the wide usage of the blockchain.

We have been witnessing a surge in law implementations impacting uses of Blockchain technologies. Several countries have passed legislation around DLT/Blockchain, and that has been paving the way to increased cooperation between regulators and other entities in this area. On the other hand, we have also noticed that several governments have also imposed bans and issued warnings against the unregulated use of Blockchain technologies. Regulatory requirements are often specific and localized; therefore a lot of aspects of the technology are not yet standardized. It is a big challenge; how regulators and early adopters can show the way for mainstream adoption.

Literature Review

The main focus of this literature review revolves around expounding the fundamental principle and technological infrastructure of blockchain technology centered on a few compelling applications in the capital market and other financial institutions.

Blockchain technology is expected to revolutionize the way transactions are performed, thereby affecting a vast variety of potential areas of application (Seebacher& Schüritz, 2017). The blockchain serves as an immutable ledger which allows transactions to take

place in a decentralized manner. It could be considered as a public ledger where once transaction performed then that transaction record stored in the list of blocks and cannot be altered in future. This chain grows as a new block is added with the chain, and this process goes on continuously (Zheng et al., 2017). These blocks are connected by a chain, which is simply a pointer or link to blocks where information is stored, and secured by a cryptographic hash. However, traditional 'chains' provide retrieval of information, but a hash pointer also provides a method to verify that data is unaltered.

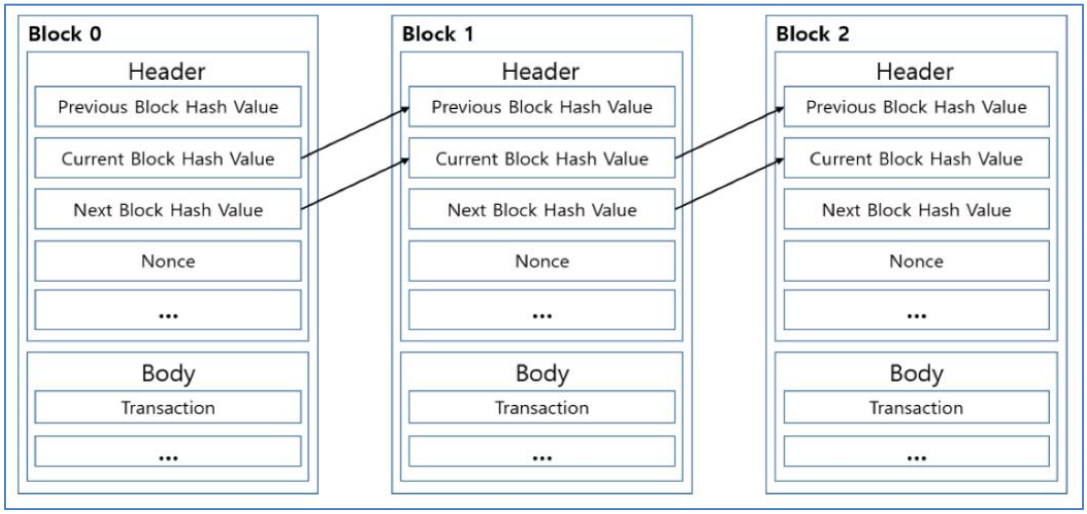

Figure 3: Perpetual sequence of blocks connected with each other
Source: Ziegeldorf, J.H.; Matzutt, R.; Henze, M.; Grossmann, F.; Wehrle, K. 2016

Public-Private Key cryptography and distributed consensus algorithms are backbones to provide a secure transaction at the user's level and data integrity at the application level. The most popular example of Blockchain use decentralized methods, but centralized distributed ledgers can also exist.

There are three key types of Blockchain. Public Blockchains allows access to any user at any time. Private Blockchains grant access to users to a private network. Consortium Blockchain is controlled by a pre-selected set of nodes which are generally a member of the consortium. They are differentiated based on various KPIs such as Speed of Transaction, Cost of Transaction, Trust.

The power of blockchain technology is it's distributed nature to avoid centralized system, a combination of the immutability of committed transactions and records and a higher level of cryptography create a trusted decentralized peer-to-peer platform.

Traditional Business Model was driven by transactions between parties through a central database owned by a 3rd party, such as a bank, stock exchanges, government.

Participants trusted the authority to maintain the data, prevent tampering and provide access when required which was time-consuming and less reliable.

Blockchain Based Business Model enables all participants to share a copy of the transaction database (the Blockchain) which validated by participants through consensus. There is no need for a 3rd party authority owing to the data immutability and protection provided by sophisticated cryptographic algorithms. The speed of transactions commit near real-time, and there is no need for reconciliation for the shared data across the chain.

Features	***Distributed Ledger Technology (DLT): Blockchain***	***Centralized Ledger (Client-Server)***
Decentralization and disintermediation	Provides direct transaction between relevant parties and eliminate the role of intermediary, lower cost, more efficiency	The transaction can be done between relevant parties only through the intermediary, higher cost, low efficiency
Greater transparency and easier auditability	All network members have a full copy of the distributed ledger (which can be encrypted). Changes can only be made when consensus is established, and they are propagated across the entire network in real-time. Little or no threat to privacy	Centralized System has the full accessibility of customer's data, and it can be tampered, modified, and distributed without knowledge or consent of the party. A huge threat to privacy
Automation & programmability	DLT allows automated agents to perform the transaction if pre-agreed conditions are satisfied between parties. This is called "smart contracts."	Mechanism of Smart contracts exists in a centralized system as well but each time consent is required from relevant parties in order to perform the transaction, increases time overhead and underutilize the potential of automation
Improved cyber-security flexibility	Because of the distributed nature, DLT provides a stronger security system than a traditional	Successful cyber-attack can damage the centralised system immensely, and recovery of

	centralised system and able to protect distributed ledger against different type cyber-attacks	data becomes very hard and expansive. Centralised systems are very prone to mishaps

Table 1: Comparative analysis between blockchain technology and centralised system Source: Natarajan H, et al., 2017

Implicit in the development of alternative ledger systems is the belief that the current model, based on a network of centralised ledgers, is imperfect (Tolga et al., 2015). In the current context of capital markets, Blockchain is a disruptive technology that creates a shared ledger between trading entities to authenticate transactions, using a distributed messaging protocol. The data on the ledger is pervasive and persistent and creates a reliable 'transaction cloud' so that transaction data cannot be lost or can only be technically corrupted by any of the participants at very high costs (Accenture Perspectives, 2018).

In the capital market, applications of blockchain technology with underlying cryptographic distributed ledger is challenging the traditional centralised applications by providing near a real-time settlement, consensus-based trust among stakeholders, lesser middle and back-office procedures, and better risk management through stronger auditability and counterparty ties. From trade cycle point of view, benefits of Blockchain can be compartmentalised based on the below figure, reflecting that Blockchain would increase the speed, and improve the transparency and quality of trade execution within Capital Markets.

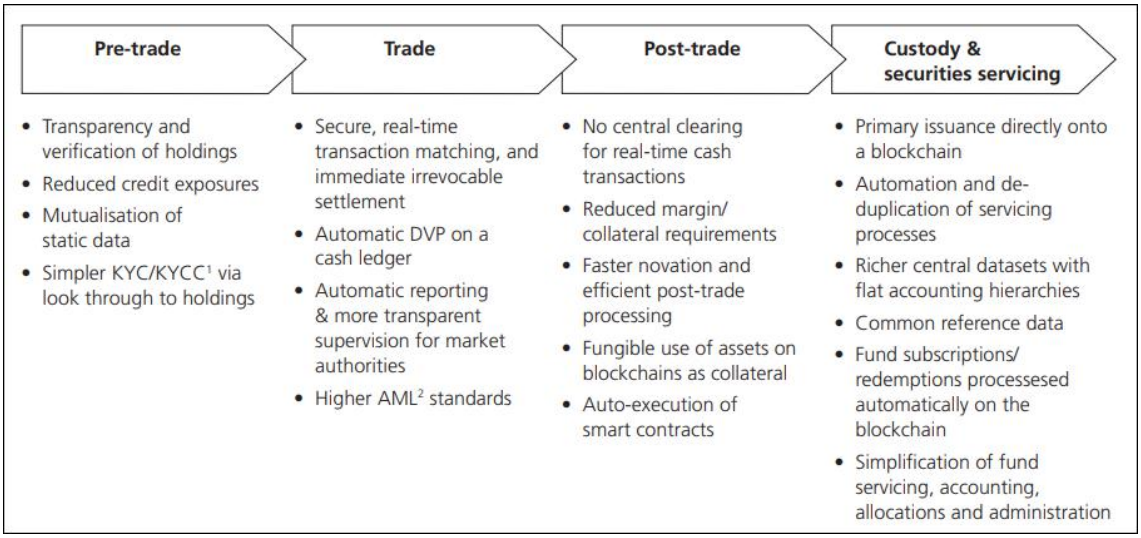

Figure 5: Potential benefit of Blockchain adoption in Capital Market Source: Blockchain in Capital Markets: The Prize and the Journey, Oliver Wyman &Euroclear report, 2016

Two major activities of the capital market named "Post-trading Clearing and Settlement" and "Know Your Custome' (KYC) alone are slowing down the operational efficiency considerably due to their dependency on a centralised ledger system. As per the report of Morgan Stanley and Oliver Wyman, the overhead in global post-trade processing is $17 to $24 Billion annually (Broadridge, 2015). This estimate covers core post-trade processing, reference data, reconciliations, trade expense management, client life-cycle management, corporate actions, tax and regulatory reporting) which is only a chunk of entire processing expenditure another chunk is Know Your Client (KYC) and Anti-Money-Laundering (AML) agreements and the estimated cost overhead of this chunk is around 12 billion per year for significant capital market players (Chan et al., 2013).

Clearing of Settlements

In the context of the capital market, the clearing and security houses are only a sole medium in the transaction process between two parties which leads intermediation charge overhead for transaction settlements that is a problem from customers' point of view (Future [inc], 2017). They are required for risk mitigation through step-by-step validation protocols.

Traditional Model: Details of trade transactions between a client, exchange, and broker are managed by a Central Counterparty (CCP). CCP confirms to all the parties involved post- verification and Settlement can be initiated only after CCP ascertains obligations and availability of assets.

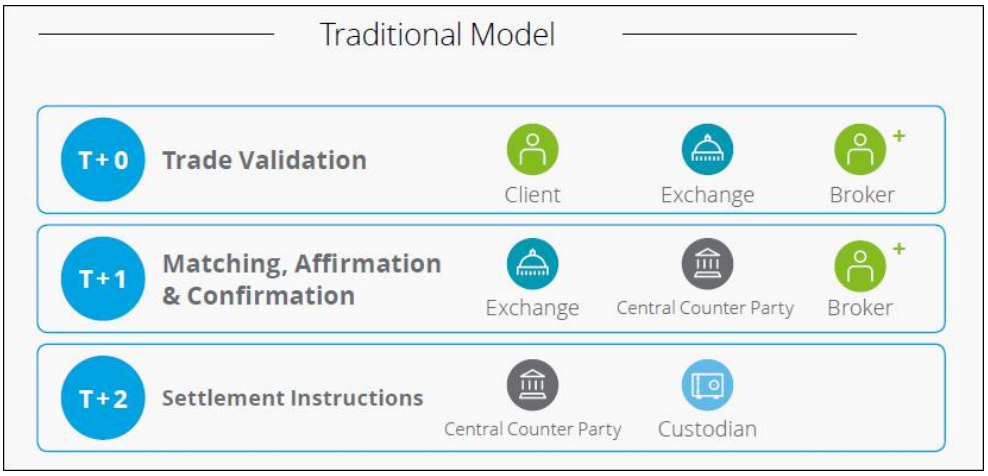

Figure 6: Traditional Post-Trade Settlement Process
Source: The Blockchain (R)evolution – The Swiss Perspective, Deloitte White Paper, February 2017

Blockchain EnabledClearing of Settlement: Near real-time settlement of transactions between participants are enabled due to underlying DLT. It has removed the requirement to lock up capital and Proof of compliance will be easier to share as regulators will have on-demand access to complete transaction history. Assets are deposited in real time

through 3rd party escrow or smart contracts, the rule-based code programmed on a Blockchain to perform a set of operations, within Blockchain systems.

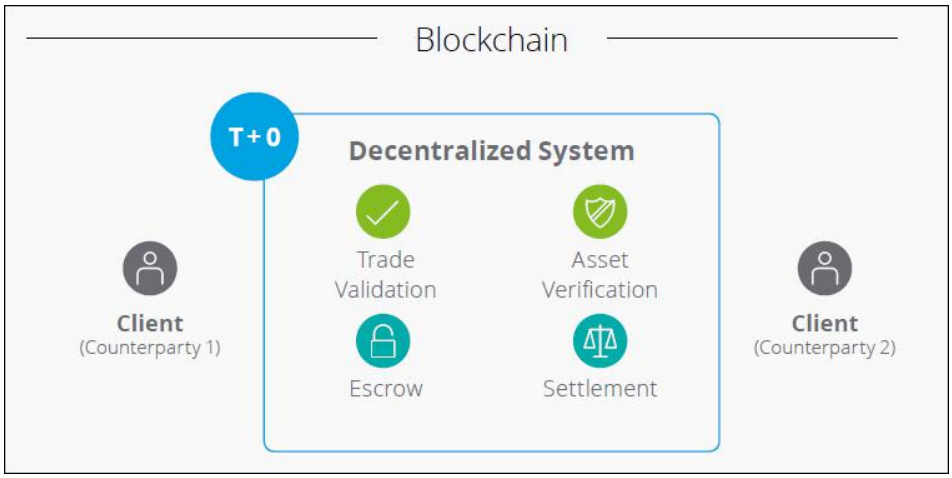

Figure 7: Post-trade Processing with instantaneous delivery versus payment using Blockchain
Source: The Blockchain (R)evolution–The Swiss Perspective, Deloitte White Paper, February 2017

The Future of Clearing Settlement: The Blockchain based Clearing/Settlement process leveraging Smart Contracts, lead to almost elimination of settlement latency, by reduction of the time required to align data prior to settlement. This reduces overall settlement risk, notably by removing delays due to database reconciliation and freeing up collateral. The smart contract automatically executes cash flow calculations through connection with 'Oracles'; third-party managed trusted data feeds that send information into a smart contract, to attain operational efficiency. The problem is that there is no guarantee that the information provided by an external source is trustworthy (Alharby&Moorsel, 2017). The onus on Oracles is to ensure the authenticity of data because, in case of mistakes, there are no rollbacks.

Key Challenge to Adoption: Maturity of smart contract execution capabilities to determine and remediate error situations. The ongoing experimentation of different design choices reflects attempts to realise some of the benefits of DLT while recognising the specific constraints of a particular use case (Bank for International Settlements, 2017).

Know Your Customer (KYC) Process And Blockchain
Each Financial Services Institution has its own Know Your Customer (KYC) storages which are usually locally managed and in silos. The entire KYC exercise is mandatory and comes with expensive and repetitive processes for managing personal information securely as per regulations, Due Diligence and Monitoring transactions of the customer.

Financial institutions spend anywhere from $60 million up to $500 million per year to keep up with KYC and customer due to diligence regulations according to a Thomson Reuters Survey. It also revealed that some banks spend up to £300 million annually on

KYC compliance, Anti Money Laundering (AML) checks and Customer Due Diligence (CDD). These measures are aimed at staying compliant with screening for sanctions, money laundering, and terrorist activities, during the entire engagement with their clients.

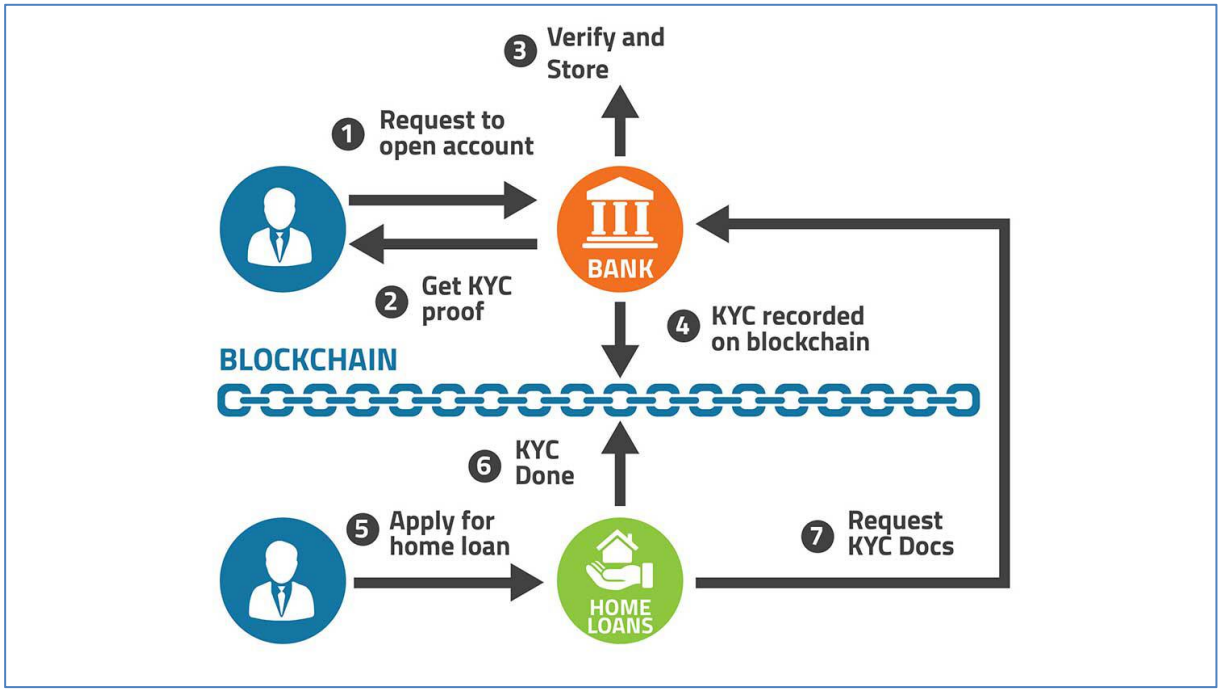

Figure 8 "KYC Storing and Sharing Process"
Source: https://www.persistent.com/new-and-emerging-tech/blockchain/know-your-customer/

Blockchain Enabled KYC/AML: Blockchain can improve expensive and inefficient KYC and AML processes with potential benefits in both headcount and penalties. It allows the data owner to exercise more control over what information is shared and with whom. It also provides customers with an opportunity to experience a more seamless experience during their interactions with several institutions.

Market providers address multiple sets of data sharing regulations with one system that would allow independent verification and result in a significant reduction in administrative costs for compliance departments.

Blockchain introduces simplification of the mechanism of complex KYC and AML clearing processes and reduction in the role of intermediaries by using distributed nodes where relevant parties can perform transaction directly in a secure and independent manner. The underlying mechanism employs a combination of a hash algorithm and the public key-private key mechanism to uphold confidentiality and apply cross-border consensus protocols to maintain data integrity. Some of the key benefits are listed below:

- Reduction in Customer onboarding and Transaction monitoring headcount due to the greater transaction transparency

- Better AML systems are expected to reduce the penalties due to increased transparency with an immutable audit trail, shared with regulatory authorities

Key Challenge to adoption: Financial institutions remain individually liable for customer onboarding; therefore, they might be hesitant to trust the vetting process of others. Efficient use of distributed ledger technology for KYC and AML will require a standardized digital identity passport, which currently does not exist. There will still be issues surrounding security and privacy of customer's KYC information but, as long as all KYC is held on a private blockchain rather than a public one, these issues should be minimal from a bank customer's point of view (FinTech Network, 2017).

Methodology

The sampling method employed will be non-random/non-probability sampling. Thus, purposive or judgmental sampling will be used instead, depending on the markets that can provide the best information to achieve the objectives of the study. This type of sampling is suitable for new developments about which little is known.

The samples for the qualitative inquiry are generally assumed to be selected purposefully to yield cases that are "information rich" (Patton, 2002), there are no clear guidelines for conducting purposeful sampling in mixed methods implementation studies, particularly when studies have more than one specific objective (Palinkas et al., 2015).

Theoretical Sample: The sampling process is entirely controlled by the emerging theory.

Maximum Variation: Purposefully picking a wide range of variation on dimensions of interest documents unique or diverse variations that have emerged in adapting to different conditions. Identifies important common patterns that cut across variations.

Criteria of selection: The basis of criteria is those sampling unit are experimenting on DLT.

Size: The study population (N) comprises of stock exchanges whereas the ten stock markets experimenting with DLT are the sample (n).

Validity criteria: Study based upon the information obtained from one individual or undertaken to describe a situation is perfectly valid (Kumar, 2005). The validity criteria considered in qualitative studies are Credibility, Transferability, Dependability, and Conformability.

Facts And Findings

The potential impact of the distributed ledger may be much broader than on payment systems alone. The majority of financial assets—such as loans, bonds, stocks, and derivatives—now exist only in electronic form, meaning that the financial system itself is already simply a set of digital records (Bank of England, 2014). This digitization of financial system has been working reasonably well in the closed system but incorporating cross-industry distributed ledger into it is difficult to set up, manage and regulate.

Blockchain technologies, over the years, have been proving their mettle in closed systems, focused on specific, specialized use and managed by a single entity for use by its clients. The initial investigation in this paper delves into the technological development and rapid adoption of blockchain technologies in major stock exchanges of the world. Since most of the stock exchanges are either deliberating or undergoing through the technological transformation for their various services, availability of quantitative data at this stage is quite scarce and qualitative data would be more appropriate instead.

The primary sources of data collection are initial reports form stock exchanges and other news portals. The key focus areas are issuance, settlement, and custody of financial instruments, along with improvement opportunities in regulatory reporting and transaction monitoring.

Stock Exchanges	***Application Development Based on Blockchain Technology***	***Status***
Australian Stock Exchange (ASX), Australia	Replacing Clearing House Electronic Sub-register (CHESS) by Blockchain enabled distributed post-trading clearing settlement process	Developmental Phase
Moscow Stock Exchange (MOEX), Russia	(i) Blockchain-based e-Voting, bond distribution, share distribution of Mutual funds	Completed & Operational
	(ii) Blockchain Based digital document flow among National Settlement Depository, Russia's Central Securitas Depository, and clients	Proposed
Korea Stock Exchange (KRX) and BLOCO, Korea	Launched "KRX Startup Market Exchange project" for documents and identity authentication by employing blockchain technology "Coin stack."	Completed and Operational
Japan Stock Exchange (JPX), Japan	Analyzing different blockchain platforms such as Hyperledger, Corda and Quorum to facilitate the issuance, dividends and stock split, ownership registry, and trade matching activities	Developmental Phase
Luxemburg Stock Exchange (LGX), Luxemburg	Luxemburg Stock Exchange using blockchain technology to notarize digital signatures to validate authenticity and proof of the existence of all filed documents	Completed and Operational

NASDAQ, USA	(i) Private shares blockchain platform called LINQ is live with Chain.com issuing the first private's shares on the ledger	Completed and Operational
	(ii) Developing an electronic shareholder voting system based on Blockchain technology that would allow shareholders of companies listed on the Nasdaq OMX Tallinn Stock Exchange – Estonia's only regulated securities market – to more frequently participate in voting processes	Completed and Operational
	(iii) Nasdaq and Strate (Pty) Ltd, the South African CSD, announced in November 2017 an agreement for Nasdaq to deliver a new Blockchain solution that would bring electronic voting to the South African capital markets.	Developmental Phase
Canadian Securities Exchange (CSE), Canada	CSE has introduced a blockchain-powered clearing platform to clear and settle securities trades. Upon approval from Canadian regulators, it would basically bypass the traditional paper-stock-certificate system and move to equity securities tokens	Pending Approval
Den Norske Bank (DNB) ASA, Norway	DNB also has several ongoing projects with various technologies including R3 Corda, Ethereum, Hyperledger, and EOS.	Developmental Phase
German Securities Marketplace and Stock Exchange, Germany	As part of 2020 roadmap, Deutsche Borseblockchain-based securities lending platform, incorporating cryptocurrency integration option, in partnership with HQLAx on R3 Corda	Developmental Phase
Stock Exchange of Thailand (SET), Thailand	Crowdfunding marketplace LiVE, using blockchain technology, to widen the access to capital funds for domestic startups by enabling peer-to-peer trading.	Completed and Operational
Tel-Aviv Stock Exchange (TASE), Israel	Collaborated with Accenture and The Floor, an Israeli fintech hub, to build a blockchain securities lending (BSL) platform aimed to allow direct lending of all financial	Completed and Operational

	instruments.	

Table 2: Key developments in major stock exchanges using blockchain/DLT

USE CASES – CAPITAL MARKETS

There are some use cases related to capital market illustrated below to expand on the developments and future prospects.

Use Case	***Description***
Distributed ledger with the custodians	A distributed ledger in a permission system with the custodian removing the need for the asset manager to maintain their own accounting book of records • Due to operational differences, custodian's book of record differs from the asset manager's investment book of records. Differing accounting rules, custodian fees are key reasons • These operational discrepancies are resolved with consensus on Blockchain, to the approach to mitigate them. The role of custodian could change into the role of safekeeping or notary of the keys. Furthermore, s/he can become the manager of automated securities-servicing operations and can manage the holding of information through smart wallet (PwC 2017)
Holding assets on the Blockchain	• Instead of holding assets at a custodian bank, assets are held in the Blockchain. This ensures that no wealth will be created or destroyed as a result of any complicated transaction structures on the system (Graham 2018) • This is subject to maturing of the regulatory environment and is currently being investigated by various regulators
Blockchain financial asset Clearing & Settlement	• Global, near real-time trading, settlement and asset transfer of stocks, bonds, structured products, and other contracts in support of existing or to create new institutional and peer-to-peer markets • Smart clearing houses for cash and securities issuing smart wallet could be the right answer for changing the settlement process under Blockchain (PwC 2017)

Corporate Information Systems (CIS) file management and trade finance	Global, cross-border trade service with the instantaneous transfer of goods and payment across known and unknown partners • Internal Blockchain repository of account relationships including the chart of accounts, signature cards, official documents (e.g. corporate resolution, articles of incorporation, etc.) and owners and authorized signers for each account. This CIS Blockchain would be used to validate identity and account/transaction access for everyday activities (wire transfers, opening additional accounts, signing loan documentation, etc.) • Mitigating risks and increasing financing revenues for banks through payment instrument digitization (Cognizant 2017)
Global handling of Syndicated loans	• Covenants handled by programmable, event-driven contracts (Smart Contracts) • Secondary Markets, consolidating ownership and issuing an SLO on a Blockchain • Loan Maintenance: monitoring of positions, ownership, tallying votes and serving as a politically agreeable shared distributed ledger. Track services at regional drawdowns, limit utilization, or distribution of fees and charges in the local syndicate banks (Capgemini 2018)
Global handling of Corporate bonds	• Issuance and trading: Blockchain combined with smart contracts can allow for direct issuance from corporates to buyers and dealers to buyers; moreover, secondary trading settlement times vastly reduced unlocking currently 'trapped' capital on banks' balance sheets allowing for better capital optimization alleviating current liquidity bottlenecks ○ Hyperledger based BondChain features peer-reviewed, proven design, performance guarantees, recurring security audit, and templates for compliance with KYC, AML and PCI regulations (www.altoros.com) • Near zero settlement time and elimination of short selling • Bond maintenance: Smart contracts implementation to automate the execution of the financial life cycle of an asset; Positions updated real-time reducing latency and offering better balance sheet optimization

Table 3: Use cases in the Capital market

Blockchain Market View

Similar to the evolution of the Internet that began on private Intranets, permissioned blockchains will give way to Permissionlessblockchains once they successfully achieve scalability and privacy. Some key changes are given below:

Cybersecurity to amplify Blockchain adoption – Amidst rising security attacks demanding cryptocurrencies, Blockchain and IoT cybersecurity will emerge with defenses based on DLT. The emergence of blockchain cybersecurity tools could hold the keys to a more secure identity approach, in which no one holds all the keys.

Increased Automation and Privatization - Digital transformation of the enterprise specifically with digitalization and digitization of processes, assets, activities, and contracts.

Governments and Regulators to boost Blockchain in Asset Tracking - Companies and organizations would offload Supply Chain monitoring activities to the public Blockchain. This will lead to a decrease in cost and regulatory burden, and an increase in customer brand loyalty.

Blockchain will link to the Internet of Things (IoT), and Artificial Intelligence (AI) - IoT devices will increasingly converge with machine learning, artificial intelligence, fog computing, and blockchain technologies. This will help create new business models and revenue streams, thus creating new kind of marketplaces where industry silos will give way to broad, horizontal structures.

Blockchain Initiatives and Art of Failing Fast - Blockchain will move rapidly from exploration into mission-critical production scenarios. Yet, it's worth remembering we are still in the early stages and the blockchains we have today probably won't be the blockchains of tomorrow (Epstein, 2017). The important thing to remember is that a given Blockchain may fail, but Decentralization as a concept is winning and changing the world forever.

Conclusion

It is quite evident that major stock exchanges have been incessantly embarking on developing an infrastructure to reduce cost-overhead and time-lag in multi-layered processes - pre-trade, trade, post-trade and custody, and securities servicing – which are extraordinarily complex, considering tightening industrial and legal regulatory frameworks and ever-increasing expectations of stakeholders.

There is cautious optimism about the future of blockchain technology in the capital market as few experts are still apprehensive about the viability of blockchain technology across geographies and regulatory spectrums. One of the examples of the uncertainty around the impact of blockchain technology is underperformance of the DLT based post-trading process in the Australian Stock Exchange (ASX) (Adams, 2018). On the other

hand, London Stock Exchange outperformed, and exchanges team witnessed more opportunity than the threat and thus implied that this is the right time to apply the DLT in the market since the team is more confident about the positive implications of DLT in the near future (Martin, 2018).

As closing remarks, I would like to emphasize that evidently, world's leading stock exchanges are gearing up to adopt the technology and be touted as pioneers in order to leverage the maximum advantage of blockchain technology. They share a vision where machines, devices, sensors, and people are connected and interdependent. Harnessing technology that allows for these processes to work simultaneously, without the need for intermediaries, will help realize that vision as an organization and as well as an industry.

This research writing would provide an opportunity to understand the common grounds and common objectives behind working on blockchain technology and provide information in common parlance to common investors.

Reference

Mainelli, M., Miline, A. (2015). The impact and potential of blockchain on the securities transaction lifecycle. Working paper number 2015-007, Swift Institute.

Crofts, B., Lam, D., &Kosmatos, J. (2018, January 29). Solving real-world problems with blockchain. Retrieved March 30, 2018, from https://www.digitalpulse.pwc.com.au/solving-real-world-problems-blockchain/

Deloitte Australia (2016). Who is using my data and how? Australian consumers want more than convenience. Deloitte Privacy Index, Media Releases. http://www2.deloitte.com/au/en/pages/mediareleases/articles/deloitte-privacy-index 100516.html

Figure 2*"Growth in Blockchain Market"* Market Reports World EstiCast Research & Consulting Research and Markets Yahoo ASD Reports Statista Allied Market Research

Market report center, https://globenewswire.com/news-release/2018/02/14/1347823/0/en/Blockchain-Market-Size-is-anticipated-to-reach-USD-60-7-billion-by-2024.html

Morgan Stanley (2017). *Blockchain: Unchained?* Morgan Stanley Research, Available September 8, 2017. https://www.morganstanley.com/ideas/blockchain-unchained/

Seebacher, S., &Schüritz, R. (2017). Blockchain technology as an enabler of service systems: A structured literature review [Abstract]. Springer International Publishing AG 2017, 279, Inbip, 12-23. Retrieved December 23, 2017. https://link.springer.com/chapter/10.1007/978-3-319-56925-3_2/

Zheng, Z., Xie, S., Dai, H., Chen, X., & Wang, H., (2017).An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends. In 2017 IEEE International

Congress on Big Data (Big Data Congress) (pp. 558-564). IEEE. doi:10.1109/BigDataCongress.2017.85

Figure 3 *"Perpetual sequence of blocks connected with each other"* Ziegeldorf, J.H.; Matzutt, R.; Henze, M.; Grossmann, F.; Wehrle, K. (2016). Secure and anonymous decentralized Bitcoin mixing. Future Gener. Comput. Syst. 2016

Figure 4*"Blockchain Based Cryptographic Digital Signatures"MerujaSelvamanikkam 2018.*https://medium.com/@meruja/digital-signature-generation-75cc63b7e1b4

Table 1"Comparative analysis between blockchain technology and centralized system" *(Natarajan H et al. 2017)* Distributed Ledger Technology (DLT) and Blockchain; World Bank Group.

Tolga, O., Roger, R., Higginson, M., Penney, J., (2015). Beyond the Hype: Blockchains in Capital Markets, McKinsey Working Papers on Corporate & Investment Banking | No. 12, December 2015

Are you exploring blockchain technology for your investment bank (2018)? Accenture Perspectives.https://www.accenture.com/in-en/insight-perspectives-capital-markets-blockchain

Figure 5 *"Potential benefit of Blockchain adoption in Capital Market"*. Blockchain in Capital Markets, The Prize and the Journey, Oliver Wyman &Euroclear report, 2016

Broadridge. (2015). White Paper: Charting a Path to a Post-Trade Utility. Retrieved December 15, 2015, from http://www.broadridge.com/broadridge-insights/Charting-a-Path-to-a-Post-Trade-Utility.html

Chan, K. K., & Milne, A. (2013). The Global Legal Entity Identifier System: Will It Deliver? (Economics Working Papers)

The Future of Blockchain (2017). Applications and Implications of distributed ledger technology. www.charteredaccountantsanz.com/futureinc

Figure 6 "Traditional Post-Trade Settlement Process". The Blockchain (R)evolution – The Swiss Perspective, Deloitte White Paper, February 2017

Figure 7 "Post-trade Processing with instantaneous delivery versus payment using Blockchain". The Blockchain (R) evolution – The Swiss Perspective, Deloitte White Paper, February 2017

Maher, A., and Moorsel. V. A. (2017). Blockchain Based Smart Contracts: A Systemic Mapping Study.https://www.researchgate.net/publication/319603816_Blockchain_Based_Smart_Contracts_A_Systematic_Mapping_Study

Distributed ledger technology in payment, clearing and settlement: An analytical framework (2017). Bank for International Settlements

Figure 8 *"KYC Storing and Sharing Process"*:https://www.persistent.com/new-and-emerging-tech/blockchain/know-your-customer/

Four Blockchain Use Cases for Banks (2017), FinTech Network https://blockchainapac.fintecnet.com/uploads/2/4/3/8/24384857/fintech_blockchain_report_v3.pdf

Patton MQ. (2002). Qualitative research and evaluation methods. 3rd Sage Publications; Thousand Oaks, CA

Palinkas, L., A., Horwitz, S., M., Green, C., A., Wisdom, J., P., Duan, N., Hoagwood, K. (2015) Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed-Method Implementation Research. Administration and Policy in Mental Health. 2015; 42(5):533-544

Kumar, R. (2005) Research Methodology: A step-by-step guide for beginners (2nd edition). London; Thousand Oaks, Calif.; SAGE.

Bank of England (2014). Quarterly Bulletin, Q3 2014

Table **2-a."Key developments in major stock exchanges using blockchain/DLT".** Corporate Overview. Retrieved from https://www.asx.com.au/about/corporate-overview.htm

Table **2-b (i).** About MOEX. Retrieved from https://www.moex.com/s348 Brief Information about Moscow Stock Exchange

Table **2-b (ii).**https://www.e-vote.ru/en/

Table **2-c.** Allan J Kim. (2016) Korea Exchange Opens Its KRX Startup Market Exchange with Blocko'sBlockchain Technology, BlockoInchttps://www.businesswire.com/news/home/20161116005521/en/Korea-Exchange-Opens-KRX-Startup-Market-Exchange

Table **2-d.**Antonovici, A. (2017,). Japan Exchange Group Bets on Distributed Ledger Technology. Retrieved from https://cryptovest.com/news/japan-exchange-group-bets-on-distributed-ledger-technology/

Table **2-e.**https://www.bourse.lu/oam

Table **2-f (i).** business.nasdaq.com/marketinsit/2016/Buildig-on-the-blockchain.html

Table **2-f (ii).**https://www.reuters.com/article/NASDAQ-blockchain/NASDAQ-successfully-completes-blockchain-test-in-Estonia-idUSL1N1FA1XK

Table **2-f (iii).** ir.nasdaq.com/releasedetail.cfm?releaseid=1049610

Table **2-g.** Carleton, R. (2018, February). CSE Unveils Canada's First Platform for Clearing and Settling Securities through Blockchain Technology. Retrieved from https://thecse.com/en/about/publications/cse-news/cse-unveils-canadas-first-platform-for-clearing-and-settling-securities

Table**2-h.**https://www.google.ru/amp/s/cointelegraph.com/news/norways-largest-bank-to-explore-applications-for-iotas-distributed-ledger-technology/amp

Table**2-i.**https://www.deutsche-boerse.com/dbg/en/about-us/insights/Consensus-2017-Deutsche-Boerse-at-blockchain-summit/303318

Table**2-j.**www.ccn.com/thailands-national-stock-exchange-launches-blockchain-crowedfunding-platform/amp/

Table**2-k.**www.coindesk.com/tel-aviv-stock-exchange-turns-to-blockchain-for-new-lending-platform/amp/

Distributed Ledger Technology – The genesis of a new business model for the asset management industry. Fundchain, PwC Luxembourg White Paper, May 2017

Digital Business - How Blockchain Can Revitalize Trade Finance (Part 1). Cognizant White Paper, August 2017

Syndicated Loans, Capgemini, 2018 https://www.capgemini.com/service/syndicated-loans/

Jeremy Epstein (2017). Why blockchains fail and decentralization succeeds, Never Stop Marketing, Venture Beat, 2017 https://venturebeat.com/2017/06/18/why-blockchains-fail-and-decentralization-succeeds/

Adams, A., &Cordukes, J. (2018). Shift to DLT may not necessarily be accretive. Global Equity Research Technology, Credit Suisse, 77-78. Retrieved from https://research-doc.credit-suisse.com/docView?language=ENG&format=PDF&sourceid=csplusresearchcp&document_id=1080109971&serialid=pTkp8RFIoVyHegdqM8EllLNi1z/k8mInqoBSQ5KDZG4

Price, M., Mills, T., &Onisiforou, M. (2018). Major opportunity, but hurdles underestimated. Global Equity Research Technology, Credit Suisse, pp.75-76. Retrieved from https://research-doc.credit-suisse.com/docView?language=ENG&format=PDF&sourceid=csplusresearchcp&document_id=1080109971&serialid=pTkp8RFIoVyHegdqM8EllLNi1z/k8mInqoBSQ5KDZG4