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Blockchain: Technology and Emerging Use Cases

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Abstract

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This thesis looks at the emerging technology called blockchain and its initial use cases that has been prominent on the market in last few years. Blockchain industry claims to provide the alternate to the traditional centralised model of doing business. Blockchain is based on decentralised model and its core idea publicly shared tamperproof ledger that allows two unknown people to share information or conduct business on a trustworthy way.

The research report takes detailed look on the technical model of blockchain and its emergence into the prominence. It also looks at the use of the few use cases based on the technology that are leading the industry and their obstacles in the process of adaption to the real world. The study involved a multi method research approach with the use of different method to collect the data. Both raw and secondary data are used to analyse the use, progress and growth of the use cases. The use cases that has been considered for this research includes the smart contracts and the application based on them like decentralised applications and decentralised finance. Use cases on the field like oracle network and supply chain management are also discussed briefly.

The results shows about the continuous development of the blockchain applications through the number of users, number of transactions and the volume of transactions. It also shows the reason in the fluctuation of these numbers over the years. The discussion phase specially talks about the advantage these applications brings on already existing system and the obstacle they are facing to displace them.

Keywords
Blockchain, Decentralisation, Technology, Application, Finance

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1 Introduction

1.1 Background

Technology has been on constant evolving process and has been an integral part of the human evolution. Information technology has been a disruptive technology since the initiation of it and continues to do so till today. They have over the years played pivotal role in shaping the future of various industries and their way of doing business. We stand on the edge of another similar disruptive technology that is about to change the way people do the business. With over two decades of research and advances in the field of cryptography and decentralization, we stand today with the Blockchain technology (Wright & De Filippi 2015,2). ”Blockchain is an open,distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way”(Lansti & Lakhani 2017). In other word we can defined it as decentralized public ledger accessible to everyone.

Blockchain term came into the wider public knowledge with the publication of the paper named “Bitcoin: A peer to peer electronic cash system” by Satoshi Nakamoto in the year 2008. The term was coined at first as hash of block (Nakamoto 2008, 2). Blockchain as a technology is still in nascent stage. However, there are many indications that the technology could impact business models across industries and economies in substantial ways (Seppälä, 2016). The first practical solution with the use of blockchain technology is bitcoin and Its value has since grown exponentially. It is one of the main reasons for blockchain current popularity (Zile & Strazdiņa 2017,12). Over the years various use cases has emerged and been proposed using blockchain as base technology to change the way the various industries and business has been working traditionally.

Although, blockchain is considerd as breakthrough invention and is expected to change the many every day activities in different every day activites across many domain. Howeever as it happens with the newly hype technology expectation may end up surprassing the actual reality and sucess. There are several challenegs like scalibility, integrity of network participants, distribution of computational power, reaching of consensus, preserving confidentiality of users and safety of the used encryption algorithms. (Zile & Strazdiņa 2017,12).

1.2 Research questions

- What is the concept of blockchain technology?
- What are the existing use cases of Blockchain technology?
- How much has the current existing use case penetrated into the daily use by the masses?
- What are the obstacles on adoption of these use cases?

1.3 Thesis Outline

The research will try and obtain the answers of the above question. The first part of the research will target to define the conceptual part of the blockchain from technological point of view. This section will be done by the use of exploratory research through various publications over the period of time through the sources like google scholar, e-books and published article over the internet. This will be done on the theoretical framework portion of the thesis. Thesis than will move into the use cases of the blockchain industry. Bitcoin which has been the successful implementation of the technology as the crypto currency and for now the only overall success is not among the researched use cases. The research will look at the other implementation like decentralized applications, oracle network and decentralised finance. The research will look at the current use of the decentralized application, its users, the field its been used to and its popularity by extracting some data from the data provider website and through the use of blockchain explorer. Decentralized Finance data will be extracted with the help of both data providing apps and etherscan explorer. Google form survey through the use of social medium or email will be conducted at the end to gaze the view of general public about the use of decentralized Finance. The oracle network this research is looking after is Chainlink and will use the chainlink main net on Ethereum network to analyse the use of it on its early adoption on the market. Chainlink has just been launched on the Ethereum main net recently, the research will look more at its challenges and advantages compared to the traditional single source oracles.

2 Theoretical framework

2.1 Blockchain

Blockchain technology is based on the distributed ledger without the need of central control. Since there is no agreed definition of the Blockchain it has been defined in various way by the different individuals or published papers. One of the best ways to define blockchain is by selecting features. Using this we can say Blockchain is a data structure with the elements such as data redundancy, checking before validation of transaction, recording of transaction on sequential order and transaction based on public key cryptography and scripting language. (Zile & Strazdiņa 2017,13).

Blockchain technology is the next step in the evolution of peer to peer economy. By combining peer to peer network with cryptographic algorithm, distributed data storage and decentralized consensus mechanism it provides a way for people to agree on a particular state of affairs and record that agreement in a secure and verifiable manner. (Wright & De Filippi 2015,5). It can be compared to the TCP/IP on the internet. The development and maintenance of blockchain is open, distributed, and shared just like in TCP/IP (Lansti & Lakhani 2017). Before the invention of the blockchain, it was impossible to coordinate the individual activities on the internet without a centralized figure ensuring no data breach has taken place. A group of unrelated individuals could not confirm that an event had occurred without relying on a central authority to verify that this particular transaction was not fraudulent or invalid. (Wright & De Filippi 2015,5).

In a blockchain system, the ledger is replicated in a large number of identical databases, each hosted and maintained by an interested party. When changes are entered in one copy, all the other copies are simultaneously updated. So as transactions occur, records of the value and assets exchanged are permanently entered in all ledgers. There is no need for third-party intermediaries to verify or transfer ownership. (Lansti & Lakhani 2017). The core idea we can get from this is that blockchain is intended for everyone to use without having one single person controlling over it. This raises the question of the verification of the transaction and double spending problem. A blockchain solves this problem through a probabilistic approach. It forces information traveling over a network of computers to become more transparent and verifiable using mathematical problems that require significant computational power to solve. This makes it harder for potential attackers to corrupt a shared database with false information, unless the attacker owns a majority of the computational power of the entire network. (Wright & De Filippi 2015,6).

Satoshi Nakamoto has talked about this on his bitcoin research paper. The solution he presented to it was to make the earliest transaction to count. For anyone to know which was the first published transaction, it was necessary to know all the transaction that has happened before. So, to accomplish this he proposed for the transaction to be publicly published and participant agree on the single history of the order in which it was received. (Nakamoto 2008).

Blockchain is a chronological database of the transaction recorded by the networks of the computers. Each blockchain is encrypted and organized into smaller data set known as the blocks. Each block contains the information such as number of transactions, reference to the previous block on the chain and complex mathematical puzzle which is used to validate the complex data associated with that block. A copy of this chain of block is stored on every computer on the networks and they periodically synchronize to make sure they share the common database. To ensure that only legitimate transaction are recorded, network only valid new transaction and do not invalid the older one. A new block of data will be appended to the end of the blockchain only after the computers on the network reach consensus as to the validity of the transaction. Consensus within the network is achieved through different voting mechanism. The common and the oldest one being the proof of work which depends on the amount of processing power donated to the network, the other of it kind being proof of stake. The block added on the blockchain is an irreversible process and anyone can use it to acess and verify the transaction through its use. (Wright & De Filippi 2015,7).

One of the main principles of blockchain is immutability of the recorded entries. For this purpose, a wide range of other computational and mathematical tools are used, Bitcoin uses hash pointer to link the preceding blocks and Merkle tree roots for the blockchain validation. Some blockchains involve certain parts of game theory for reaching consensus within a decentralized network, where there is a possibility of network subverting by malicious users. Exact mechanisms for achieving immutability depend on the intended application of blockchain and its scalability and accessibility. (Zile & Strazdiņa 2017,14)

Before the Blockchain invention, there was no way to manage individual activities over the Internet without centralized control to ensure nonrepudiation of data. There was no trust between the parties that none of them could change the data for their own profit without agreement with the second party. A group of distributed individuals could not verify transactions without relying on centralized authority. This problem was mostly known as the “Byzantine Generals Problem” (Wright & De Filippi 2015). It was questioned how distributed computers could decide without relying on a central authority, for the network of the

computers to be able to defence against an attack from ill-intentioned actors. The problem assumed that the three parts of the Byzantine army are waiting outside an enemy city and planning to assault it. The generals of each division are independent, and to be able to conquer the city, they need to have a common course of action. However, the generals' abilities to communicate with one another are restricted to a messenger service, and there is a traitor who is actively ruining the generals' actions to make a consoled decision by either tricking them to attack before others or missing some relevant data so that there is no opportunity to make united attack (Wright & De Filippi 2015). Blockchain uses a probabilistic approach as the solution for Byzantine Generals(Nakamoto 2008). Data is moving through the networks of computers which in turn enables increment in transparency and reliability. This will reduce the attacker's ability to corrupt the distributed database with the fake data. The attack only becomes successful when attacker posses the higher computational power than the entire network. Blockchain protocols thus ensure that transactions on a blockchain are valid and never recorded to the shared repository more than once, enabling people to coordinate individual transactions in a decentralized manner without the need to rely on a trusted authority to verify and clear all transactions. (Wright & De Filippi 2015).

Figure 1 below shows the how the chain of blocks are interconnected with each other. Each block consists a hash of the previous blocks, timestamp and the transactional data. When one block is completed with transaction another block is created with the same attributes and the hash of the previous block to keep the chain going.

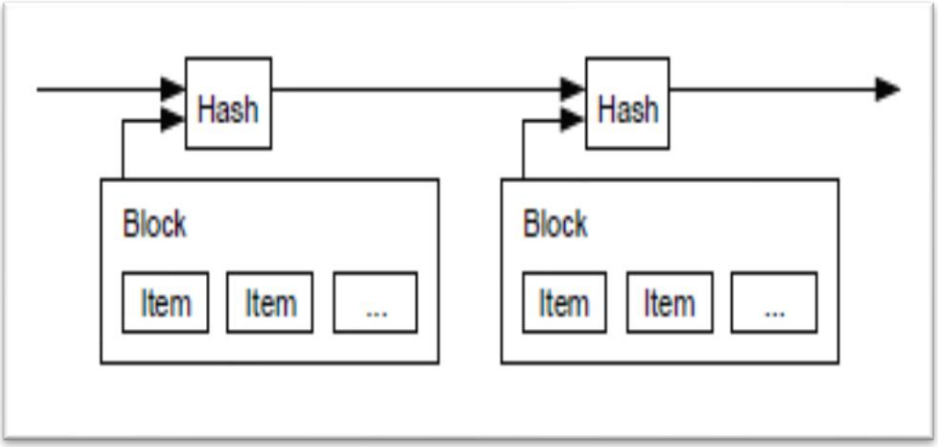

Figure1. Connection of Blockchain blocks (Nakamoto 2008,2).

Each owner transfers the coin to the next by digitally signing a hash of the previous transaction and the public key of the next owner and adding these to the end of the coin. A payee can verify the signatures to verify the chain of ownership. A timestamp server

works by taking a hash of a block of items to be timestamped and widely publishing the hash, such as in a newspaper. The timestamp proves that the data must have existed at the time, obviously, in order to get into the hash. Each timestamp includes the previous timestamp in its hash, forming a chain, with each additional timestamp reinforcing the ones before it. (Nakamoto 2008).

The blockchain networks works on the following way (Nakamoto 2008).

- Transactions are brodcasted across all the nodes.
- Every node collects transaction into the new block.
- Each nodes works on solving the complex mathamatical problems(proof of work) for its blocks.
- When a nodes finds a proof of work it brodcast it to all the nodes.
- Nodes accept the block only if all transaction on it are valid and not slready spent.
- Nodes express their acceptance of the block by working on creating the next block in the chain, using the hash of the accepted block as the previous hash.

2.1.1 History of Blockchain

General perception among the public is to associate bitcoin and blockchain together. Lots of people are unknown to the fact that Blockchain goes way beyond the bitcoin and was invented more than decade before bitcoin even came into the picture. Below I present the simple timeline on the development of blockchain.

- In 1991, Stuart Haber and W. Scott Stornetta envisoned the currently known blockchain technology. Their first work involved cryptographically secured chain of blocks which couldnt be tamper with timestamp of documents. (Goyal 2018).

- In 1992 Merkle tree was incoropated and that made it possible to have more than one documents on the single block.

- In 2008 Satoshi Nakamoto releases bitcoin research paper for peer to peer digital payment system which begins the first experiment using this technology. (Nakamoto 2008)

- The next innovation brought blockchain as a name on foreground, which was essentially the realization that the underlying technology that operated bitcoin

could be separated from the currency and used for all kinds of other interorganizational cooperation. (Gupta 2017).

- Smart contract came next, which was embodied by the second must successful blockchain based project till date named Ethereum. Ethereum allowed to build a program directly into the blockchain that allowed financial instruments, like loans or bonds, to be represented, rather than only the cash-like tokens of the bitcoin (Gupta 2017).

- Next phase was decentralised application and many platforms has popped up over last few years with promise of building the infrastructure to make this successful.

- Blockchain scaling is the ongoing phase where work is been done too accelerate the speed of the blockchain network for transaction and other work. Currently on blockchain every computer in the network process every transaction. A scaled blockchain accelerates the process, without sacrificing security, by figuring out how many computers are necessary to validate each transaction and dividing up the work efficiently (Gupta 2017).

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- 2018 and ahead blockchain application has become trend in the industry and is trying to solve the real-world problems searching the path for more user-friendly products.

- Blockchain technology continues to evolve on current days depicted by increased number of cryptocurrencies as well as Companies leveraging the technology to enhance Efficiency. (Goyal 2018).

The figure 2 shows us how the blockchain technology has moved forward over the time with the changing use cases emerging over that period. From the emergence of Bitcoin whitepaper to the introduction of Ethereum and the subsequent growth of blockchain based applications.

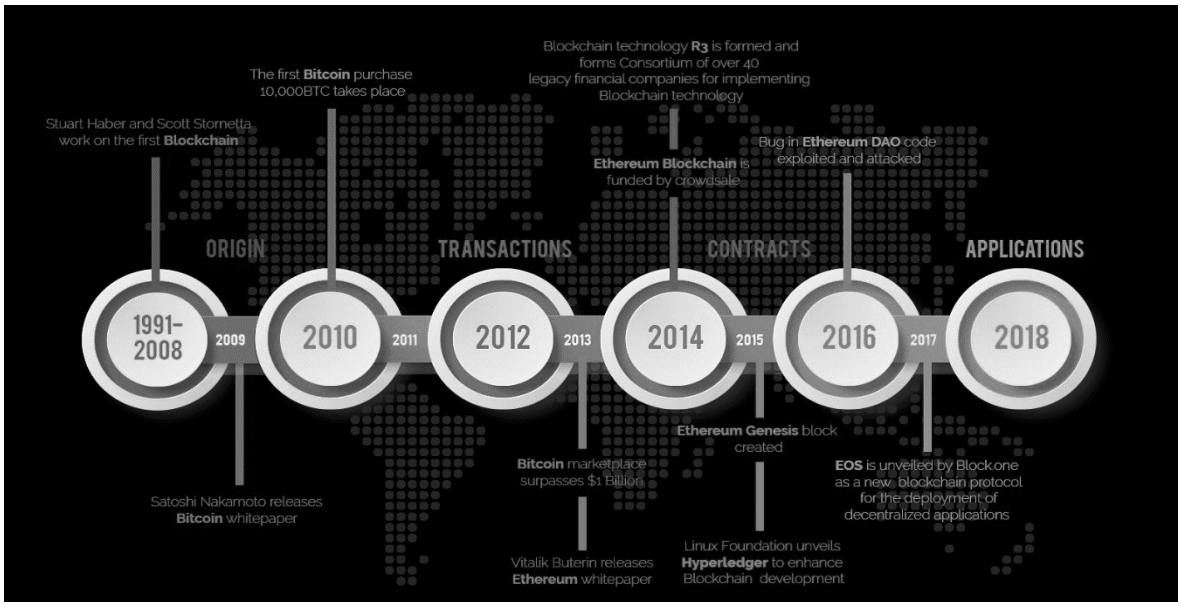

Figure 2. Pictographic representation of Blockchain history (Goyal 2017)

2.1.2 Types of Blockchain Architecture

From above we have come to know that blockchain is a distributed ledger where all the computers or nodes on the network possess the copy of the network transaction. However, on the basis of blockchain type it can either be more or less decentralized. Broadly it can be put on three category private, public and consortium blockchain architecture (Lastovetska 2019).

Public blockchain are open to everyone to join the network, Bitcoin is one example of the public blockchain network. To some, this is the only kind of blockchain that makes sense as it brings the most value in the sense that there are other easier, faster and cheaper database models for more private data holding (Seppälä 2016).

Private networks are intended for the control by specific organization and restricted to the ones with the invites. In a consortium structure network is controlled by the preliminary assigned users (Lastovetska 2019).

The table 1 shows the similarities and differences among the different architecture in terms of consensus, efficiency and centralization.

	Public Blockchain	Private Blockchain	Consortium Blockchain
Consensus Process	Permission less	Needs permission	Needs Permission
Read permission	Public	Public or restricted	Public or restricted
Consensus Determination	Mining	Single Organization or entity.	Nodes
Efficiency	Low	High	High
Centralization	No	Yes	Semi

Table 1. Comparison of different blockchain architecture (Lastovetska 2019).

2.1.3 Consensus Mechanism

Consensus mechanism is a key element of the blockchain technology. Its role is to 'decide' on the right order of transactions and this way, retain consensus among the different versions of the database (Seppälä 2016). There are mainly two types of mechanism to achieve consensus in current blockchain industry. One of them is proof of work and other being proof of stake.

Satoshi Nakamoto on his Bitcoin paper theorized that only way to overpower the blockchain network is 51% attack. He has proposed the proof of work system to prevent any single entity take control over the network. Proof of work is central to the concept to make the bitcoin as trust less and distributed consensus. On a proof of work mechanism, A group of transaction are bundled in the memory pool and miners verify the transaction by solving the mathematical puzzle. First miner to solve the transaction gets the newly minted coin along with the transaction fee and the verified memory pool becomes a block and gets added to the blockchain. (Schumann 2019).

Proof of Stake systems have the similar purpose of validating transactions and achieving consensus. In this system a miner of the new block is choosen on the basis of the amount of coin they have staked. Biggest differnce between two is the POS system is much more environment friendly and helps in conserving of the energy.

2.1.4 Risk of blockchain

Possibilities always come along with risks. Each core function of blockchain has several significant threats that need to be evaluated and counter measured before implementation. Not always these risks will be purely technical, because risks can also arise from legal, economical, even cultural areas. (Zile & Strazdiņa 2017,14). Few of them have been mentioned below.

- Blockchain with proof of work consensus could get 51% attack, meaning a single node taking control over the network. This will give that node a sole control over mining the block and confirming the transaction.
- Sybil attack is also a threat where a malicious nodes could flood the network with fake users.
- Since Blockchain is a new technology, reason for possible security risks is a lack of academic research and subsequent standardisation of industry security measures. (Zile & Strazdiņa 2017,14)
- Some legal risk like data privacy, legal jurisdiction, dispute resolution and regulatory risk of government also exists.

2.2 Application of Blockchain Technology

During the ICO boom of 2017 blockchain started to get greater recognition among the wider audiences. This led to the increase in number of project that was based on blockchain which intended to provide the variety of services and software with the use of the technology. Unfortunately, as it is common at an early adoption stage, there are a lot of unrealistic proposals and expectations, sometimes even deliberate fraud to trick the investors. So, it’s very important to understand the limitation of blockchain, its possible applications and the benefits. (Zile & Strazdiņa 2017,14).

From the above we have already come to know that Bitcoin was the first application or use case of the blockchain technology. Other peer to peer payment currency based on blockchain with proof of work as the consensus mechanism are very similar with some having added privacy factor. Here onwards we will try and explore few other use cases that has emerged after the bitcoin technology. Some of them have been implemented, some of them are been worked on and some of them are just are only on being proposed or at the theoretical stage.

2.2.1 Bitcoin

The most well-known application of the blockchain technology currently is Bitcoin. On the pseudonym of Satoshi Nakamoto, a person or a group of people on 2008 released a paper called Bitcoin: A peer-to-peer Electronic cash system. It describes a peer to peer version of electronic cash system that goes through one party to another without the need of third party or central authority to verify the transaction (Nakamoto 2008). It's a world most well-known crypto currency. Bitcoin has strength by design to make it a viable currency that has elevated it in status over the years, more notably the fixed limit of bitcoin that will exist (Devries 2016, 2). The maximum number of bitcoins that can be mined is caped at 21 Million with 18 million currently on the circulation. The finite number of bitcoin prevents an overabundance and ensuring its rarity and its value on the process.

Bitcoin has grown on value year by year since 2008 and the figure above shows its rapid growth of value compared to the US dollar. Bitcoin is the best performing asset in financial market in last decade. An average person can buy, sell or trade bitcoin through different exchanges available all over the world. For the transaction on bitcoin, Payer needs to broadcast the bitcoin public address of the destined person or payee and the amount of bitcoin to be transferred. Every address also contains on a private key and they are used to access the bitcoin address. Private key along with public key allows an individual to digitally sign the bitcoin transaction on the network. (Kroeger 2013).

On the figure 3 we can see the ups and downs of the bitcoin run in the market with its peak being January 2018 and the subsequent decline and slow growth that's taking place after the bottom it hit on December 2018.

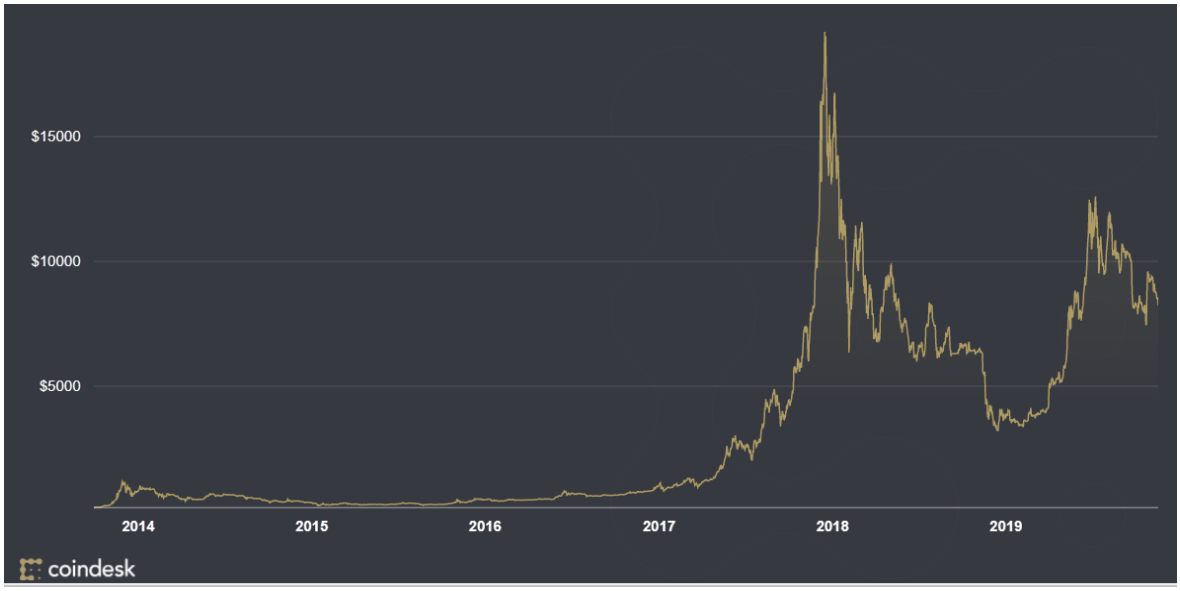

Figure 3. Historical price movement of Bitcoin against US dollar. (Coindesk.com)

2.2.2 Smart contract and Dapps.

With the launch of Ethereum platform in 2016, The smart contract came into the fore front of the blockchain innovation. This started the 2nd generation cycle of blockchain that went one step ahead from just been peer to peer payment network to some potential different use case for the first time. Before that some other blockchain project like name coin, color coin and meta coin did try to establish alternative application of the blockchain technology but never could get the mass attention like the Ethereum.

According to Ethereum white paper, “The intent of Ethereum is to create an alternative protocol for building decentralized applications, providing a different set of tradeoffs that we believe will be very useful for a large class of decentralized applications, with particular emphasis on situations where rapid development time, security for small and rarely used applications, and the ability of different applications to very efficiently interact, are important. Ethereum does this by building what is essentially the ultimate abstract foundational layer: a blockchain with a built-in Turing-complete programming language, allowing anyone to write smart contracts and decentralized applications where they can create their own arbitrary rules for ownership, transaction formats and state transition functions. ”

The automated, verifiable and trustless nature of smart contracts has added a new aspect of tangible blockchain uses in the real world, one that allows it to pose a serious challenge to the majority of centralized industries. Most traditional businesses rely on legal infrastructure and agreements in order to conduct business with third parties. This requires a variety of middlemen, as well as incredibly big budgets dedicated to documentation processing and contract enforcement. By opting for a blockchain-based smart contract system, most businesses can reduce the risk of fraud and the costs of middlemen, whilst avoiding having to hand all data over to another centralized entity. (lisk 2018).

Decentralized apps are the application which backends are running in the blockchain. Frontend is very similar to the traditional apps. It has a wallet for the puropose of managing the cryptographic key and adress to connect to the blockchain. Identifcation of user is done by the use of public key infrastructure. Dapps are also known as the web 3 application.
Few advantages of dapps over traditional apps are listed below.

- Faster payment processing without the need of integrating the payment gateway

- Much more secure being governed by private key compared to the traditioanl app which isnt cryptographically secured.
- Easy to verify data as all the data are available in public blockchain. (Patrick 2019).

Figure 4 shows the difference in the structural build between the traditional apps and the blockchain based decentrlaised apps. Traditional app are based on the database and are connected to it by the use of an API while the decentrlaised apps are based on the blockchain and are connected to it through the layer of smart contract.

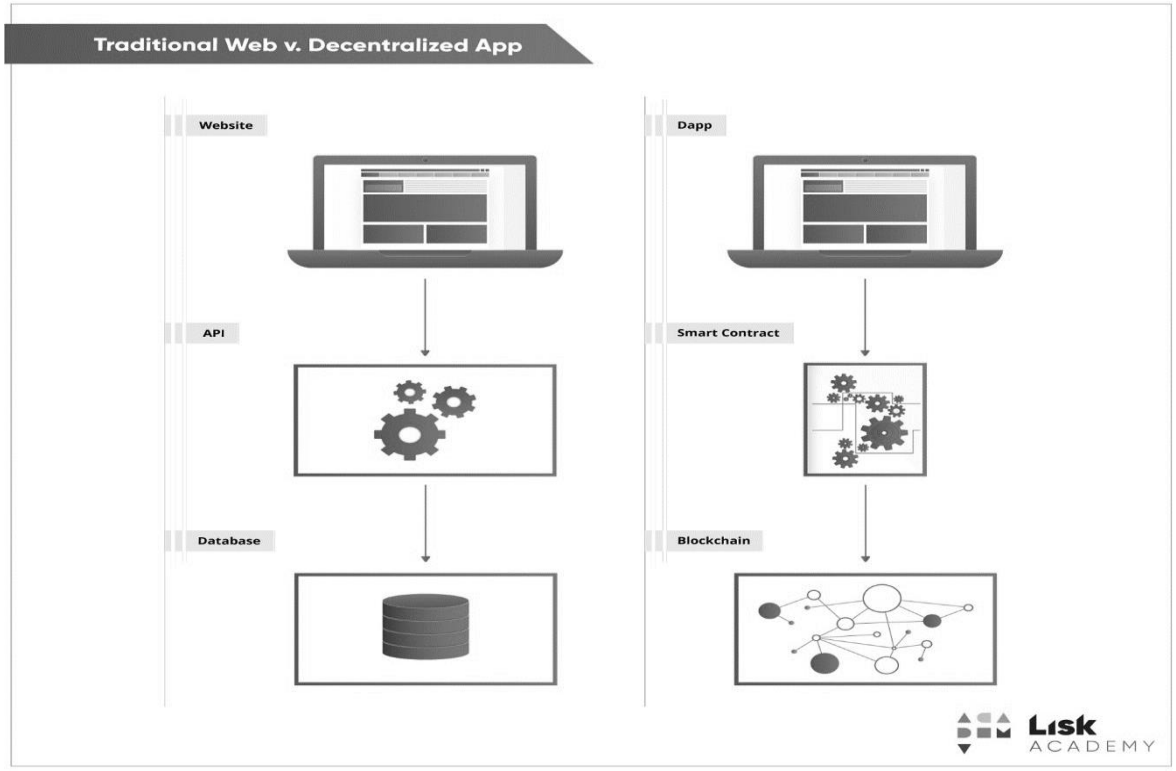

Figure 4. Traditional app vs Decentralized apps (Source: Lisk Academy)

2.2.3 Oracle Network

Traditionally oracle was known as the individual or an agency providing counsel or prediction on future events. Smart contracts are poised to revolutionize many industries by replacing the need for both traditional legal agreements and centrally automated digital agreements. Both performance verification and execution rely on manual actions from one of the contracting parties, or an automated system that programmatically retrieves and updates relevant changes. Unfortunately, because of their underlying consensus protocols, the blockchains on which smart contracts run cannot support native communication with external systems. (Ellis, Jules & Nazarov 2017). The growing need for external data flowing into blockchains and, by extension, smart contracts has led to

debates and innovation around Oracles. Oracles are data feeds from external systems that feed vital information into blockchains that smart contracts may need to execute under specific conditions. Oracles retrieve and verify external data for blockchains and smart contracts through methods such as web APIs or market data feeds. The type of data required by smart contracts can include information on price feeds, weather information, or even random number generation for gambling. (Curran 2019).

Existing oracles on the industry are centralized which will just need failure of one source to disfunction making it a major security problem. Chainlink, The oracle we are looking for this project provides the solution for this issue by providing the middelware solution of decentralized oracle network. Chainlink interface contains nodes that reply to queries made by the contracts. ChainLink contracts are designed in a modular manner, allowing for them to be configured or replaced by users as needed (Ellis, Jules & Nazarov 2017).

On chain interface of the chainlinlk consists of following components. (Curran 2019)

- Reputation contract: It consists of method to track and store the metrics of the oracle service providers.
- The Order-Matching Contract: It takes a service level agreement (SLA) and logs the data parameters of the SLA while simultaneously taking bids from oracle providers. (Curran 2019)
- Aggregating Contract: It collects the response of oracle provider and finalises the collective result for the queery of the contract.

The figure 5 shows how the Chainlink platform performs the whole request process. When requestorcontract is sends on chain data, chainlink contract calls for the chainlink node which conects and retrive the data by the use of an API. Thn the Node transfers the response recieved from the API to the adapater. Adapter encrypts the and send forward to the TCF which finally uses the result and mkaes it available for the requestor.

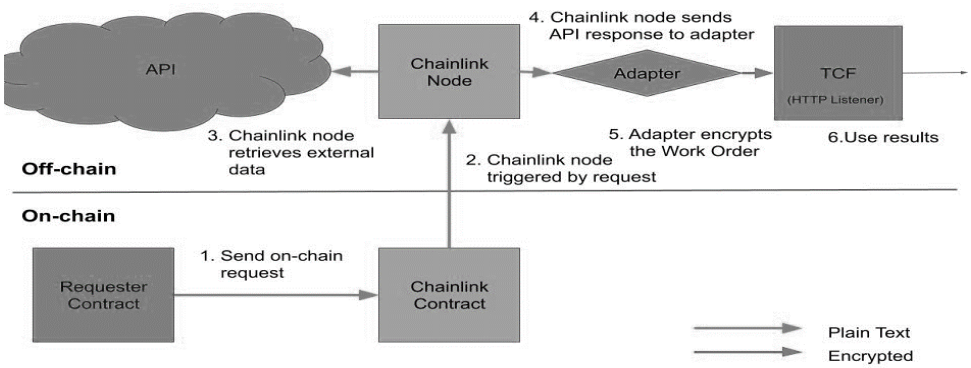

Figure 5. Diagram showing the request process on Chainlink. (source: blog.chain.link)

2.2.4 Decentralized Finance

Decentralized finance or popularly known as DeFi is arguably the fastest growing use case of the blockchain technology. It uses smart contracts to facilitate a robust market where users can lend, borrow, and generate interest on their own money, as well as make bets and gain/reduce exposure to assets and events, all without a central coordinator (Yarmosh 2019). Comparing it to the traditional finanace market, DeFi offers various adavantages like transparency, price efficency, speed and ease of access and most importantly censorship resistance. The most compeling oppurtunity for DeFi in near term has been its potential to provide the oppurtunities to average investor which was only been accesible to the super rich. Some of the advantages of DeFi over the tradiitional method are listed below.

- Capital access becomes much easier to the large part as people living in the controlled stated can get theie hands on the stable cuurenices can convert them to the recognized FIAT currencies like dollar, euro, etc.
- Transparency is the forefront of the DeFi revolution with borrowing and lending is determined by the market participants and loans are secured through the use of overcollateralization.
- The processing speed is much faster compared to traditional market and getting loan is much more easier.

2.2.5 Other use cases

There are various use cases that are currently being used, developed or on the process. I am listing few of them below.

- Security Token: Tokenization of traditional asset like real estate, equity, shares etc. has been discussed and currently being implemented across various platform. Security token offering on blockchain is currently being highly speculated as next step in the adaption of the technology by larger masses.
- Cyber security: Tamper proof nature of the blockchain makes it ideal for the solution in battering the cyber security problems.
- Insurance: Smart contract can play vital role here to provide transparent environment between the company and customers.
- Supply Chain management: Blockchain can help solving the problem of transparency of product move in the industry. Products can be assigned individual identity in the chain and can be tracked its move through it.

- Health care: Blockchain can provide a secure medium to store the patient medical history and making the job of the medical personal much easier.

3 Empirical part

The quantitative and secondary method of research was used during this thesis project. Quantitative method is data oriented and it perfectly suits the requirement of this research project which is looking for the adaptation of some of the existing use case of the blockchain industry. Online Survey method was chosen to gain the perspective of the user of some of the products that has been laid out and in use and also to gauge their opinion on how it will evolve and what other use cases can they see emerging over the period of time.

Secondary method of research means using the existing data that is already available. This is very vital for this research project, Blockchain as mentioned already above in theoretical portion is the distributed ledger that keeps the record of every existing event happening on it. Since the research is looking for the use of the dapps and DeFi applications the data that already existed played a big part to analyse how it has progressed what it has achieved since its inception. This research has used five existing data providing website and Ethereum blockchain explorer etherscan to gather the data for the purpose of analysis.

3.1 Research Methods

Research Method 1

The first research method used in this is secondary method of data collection through the various websites that tracks the data of the dapps and DeFi applications and present them in web UI form. This is fundamental to this research as we are searching for the current case scenario on adoption of various decentralized blockchain based application. These are the raw live data extracted out of the blockchain itself and represents the exact value of the use in terms of users, transaction and volume. Though the data is obtained from the secondary resources, in this case most of the data are verifiable using the blockchain itself. Using the secondary resources like various website just eases off the process and save the time instead of building or using the available API’s to extract the data of the chain.

Research method 2

The survey was chosen as the quantitative method of data collection in this research project. As the first research method gives us the live feed of data of various blockchain based application , survey was primarily used to gauge the direct interest of people on kind of application they are using and for what purpose. The question on the survey included which application platform they are using, how long they have been using and what purpose they use it for. Also, the survey asked for their view of the people about how they see it developing further forward in the future and if it's able to compete or replace the traditional or currently famous methods. The people used were asked the question through the twitter and telegram which helped me reach the group of people who are very familiar to the topic and has been using such applications for considerable time. Telegram is very famous among the blockchain based company and there are numerous group where people use it to discuss the technology, its growth and implication on the future. This made telegram precise medium for the survey to reach the right people it was targeting.

3.2 Data Sources

This portion will talk about the websites which were used for the collection of the data and method used in the collection both secondary and quantitative data. The dataset collected includes the information about dapps and their uses, data on the use of DeFi products, use of chainlink decentralised oracle network and the survey conducted among the general public.

3.2.1 State of the Dapps, Dapptotal and Dapp.com

The state of the dapps collects the data on the decentralized apps which runs across several blockchains. Their website describes themselves as non-profit curated directory of decentralized application. This website was founded in 2017 and any dapps developer can submit their app to the website to get it published. Website is free of cost and helps in categorising the dapps into different field of use they represents. The website provides description, category and smart contract address of each dapp and tracks the daily transaction, number of users and volume.

Dapptotal is very similar to like state of the dapps and they keep and track the data of the various dapps on the basis of transaction, number of user's, volume and categories. They have 4300 dapps registered and have 100+ indices and data indicator showing the com-

plete picture of the dapp market. Dapp.com is very similar to the previous two with the additional benefit of having publicly released quarter to quarter statistical report on dapps on various platforms.

3.2.2 DeFi Pulse and DeFi.Review

Both websites DeFi pulse and DeFi.Review keeps track of the DeFi products and rank them according to total value locked in the smart contracts and volume. They present the on-chain data in readable form and makes it easy for the use for the various purpose.

3.2.3 Etherscan

Etherscan is a block explorer, search, API and analaytical platform for the Ethereum blockchain. It collects blocks, transaction, user address and smart contract adress and present it as web UI. It is basically a search engine that allows users to easily lookup, confirm and validate transactions that have taken place on the Ethereum Blockchain.

3.2.4 Survey

Survey was conducted using google form through the use of social media platform like Twitter and Telegram. The survey was based on the use of the DeFi application that are currently on the market. Social media was the perfect platform for me to use it to target the group of people who were already familiar with DeFi and are using it on some form.

3.3 Data Collection

There are over 3100 dapps registered on the state of dapps by the end of October 2019. They have listed the dapps across various platforms like Ethereum, EOS, Tron etc. For the simplification of the data collection and keeping the sample to reasonable level for the analysis, the dapp researched will be only be based on Ethereum blockchain. The dapp part of research includes the data collected for the first three quarter of the year 2019. The DeFi part will look at the top category application above various chain and the data collected are for the last one-year period with the cut-off date being 15th November 2019.

3.4 Working condition and Limitation

During the phases of the research, I had to check my biases constantly. I am into this field for last 3 years and has done my own research through various medium during this period. I have my own preferences, likes and dislikes and views on the industry and how it is progressing and the future it may or may not have. So, it was very important for me to remain unbiased and find the result out purely on the basis of the data collected through the research methods. Next up was timeframe to complete the task and I wanted to keep the samples to the reasonable size so that it won't be messed up and difficult to find the result and conclusions.

Survey done during the research was targeted among the people who are already familiar with the blockchain technology and have used its application on some form. This doesn't target the general public which may or may not be familiar to the subject, this creates the limitation on some answer to the surveys and could be very biased view specially on the question of future viability of the applications. The research data conducted both using secondary method and survey are all based on Ethereum Blockchain platform. This was done to ensure the quality of data obtained is high and as said above to keep the sample size to reasonable amount. Ethereum was and currently is leading platform when this research was conducted. This will definitely create a limitation in research with other established platform data not being considered.

3.5 Results

3.5.1 Decentralised Applications (Dapps)

The figures 6 and 7 posted below will shows the growth of the dapps by the number of active users and by the number of transaction recorded on the blockchain.

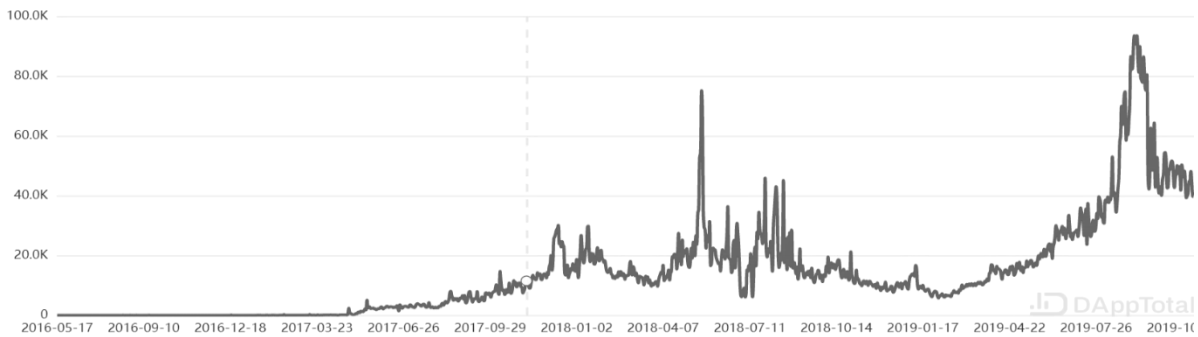

Figure 6. Number of Daily users based on Ethereum blockchain dapps. (Dapptotal.com)

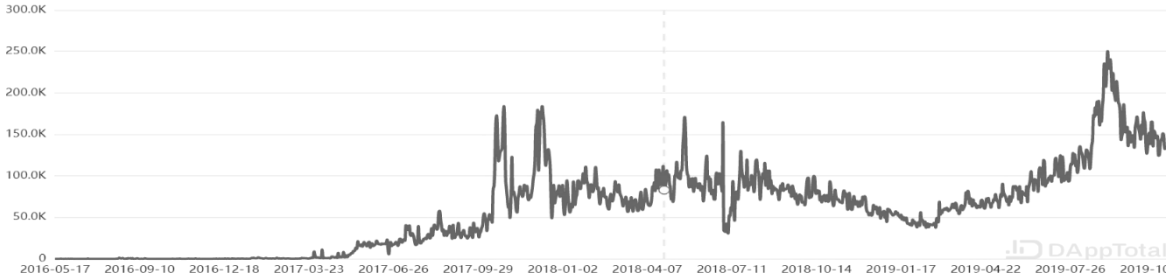

Figure 7. Number of daily transaction on Ethereum blockchain dapps. (Dapptotal.com)

Dapps are broadly divided into various category according to their uses in different field. This chart 1 below shows the number of Ethereum based dapps across various categories.

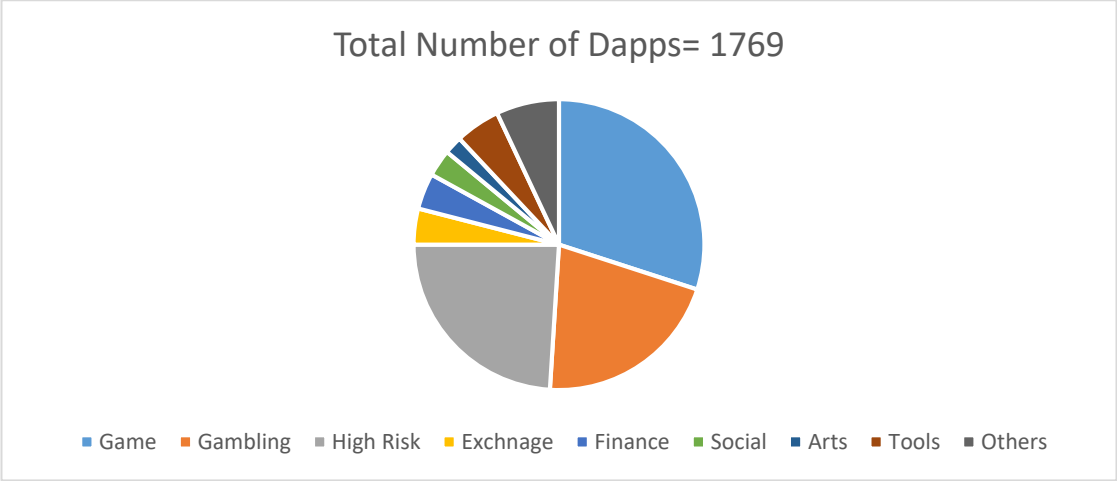

Chart 1. Total Number of Ethereum Dapps by category.

The table 2 compares dapps across different quarters on the basis of users, transactions and volume. First table will compare the use of dapps s on the basis of active users, user activeness and dapp user percentage. Second table is comparing them on the basis of volume and transactions.

	Quarter 1 2019	Quarter 2 2019	Quarter 3 2019
Total users	1,151,657	1,444,492	1,761,369
Active users	186,554	365,112	392,078

User Activeness	16.20%	25.28%	22.26%
Main net address	60,105,639	69,134, 853	76,101,434
Dapp user %	3.7%	2.09%	2.31%

Table 2. Comparison of Dapps across different quarters on the basis of users. (daap.com)

	Quarter 1 2019	**Quarter 2 2019**	**Quarter 3 2019**
Transactions	5.18 million	6.04 million	5.28 million
Volume (Dollar)	202.22 million	621.98 million	804.36 million

Table 3. comparison of dapps across quarters on the basis of transaction and volume (dapp.com)

The table 4 shows the comparison of different category of dapps on the basis of volume of transaction over different quarters. All data included are measured in terms of Ethereum.

Category	**Quarter 1 2019**	**Quarter 2 2019**	**Quarter 3 2019**	Total
Exchange	790,499	921,592	706,144	2,418,235
Gambling	635,499	950,392	196,151	1,782,042
High Risk	In Others	460,796	706,144	1,166,940
Finance	In Others	In Others	2,275,353	2,275,353
Games	30,999	28,799	39,230	99,028

Others	46,500	518,395	0	564,895
Total (Ethereum)	1,549,998	2,879,974	3,923,023	8,352,995
Total (Dollar)	202,218,095	621,981,266	804,362,687	1,628,562,048

Table 4. Ethereum Dapps total volume of transaction indicated in Ethereum. (dapp.com)

3.5.2 Decentralised finance (DeFi)

This section includes the results about the use of DeFi applications. This will show the amount of US dollar locked across various DeFi applications and also about the growth of locked amount over the last one year.

Name	Chain	Category	Locked
Maker	Ethereum	Lending	349.1 Million
Compound	Ethereum	Lending	109.8 Million
Synthetix	Ethereum	Derivatives trading	103.3 Million
InstaDapp	Ethereum	Lending	34.4 Million
dYdX	Ethereum	Lending	31.4 Million
Uniswap	Ethereum	DEX	26.2 Million
Nuo Network	Ethereum	Lending	10.1 Million
Lightning Network	Bitcoin	Payment	7.2 Million
Bancor	Ethereum	DEX	5.7 Million

Table 5. DeFi applications arranged on the order of locked value of US dollar. (defip-ulse.com)

Figure 8 shows the growth curve of the dollar value locked in the smart contract across various DeFi applications over one-year period. It is shown on the pictographic graph taken out from defipulse.com website.

Figure 8. Amount of US dollar value locked on DeFi applications. (defipulse.com)

3.5.3 Survey

The first research method shows the growth of blockchain based decentralized application and decentralised finance over the period of last year. This method is trying to get the general consensus among the early users of these products and their view on how they see this space shaping up in the future. The data obtained from here will be further discussed on the discussion phase of this research.

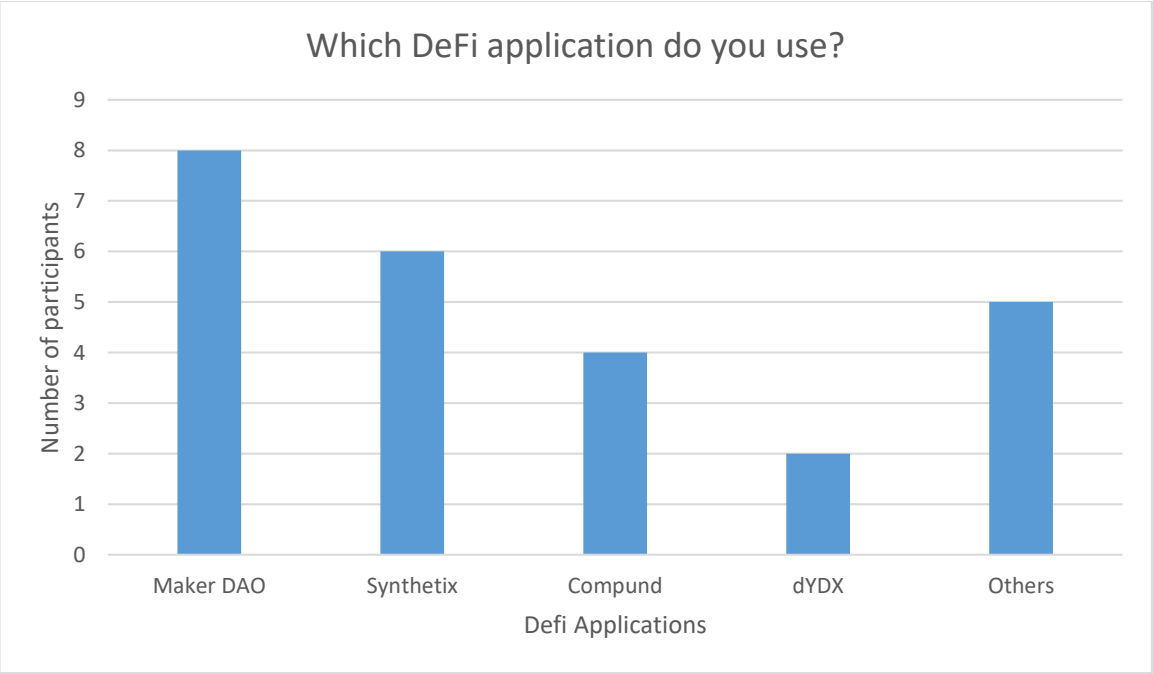

Chart 2. DeFi applications used by the respondents

The chart 2 can corelate with the table 5 which shows Maker DAO as the application with most amount of value of US dollar locked in their smart contract. 8 out of 15 respondent showing they are using it currently. Synthetix exchange which trades derivatives products follows up with 6 participants conforming of using it. Respondent could give multiple answers in this question.

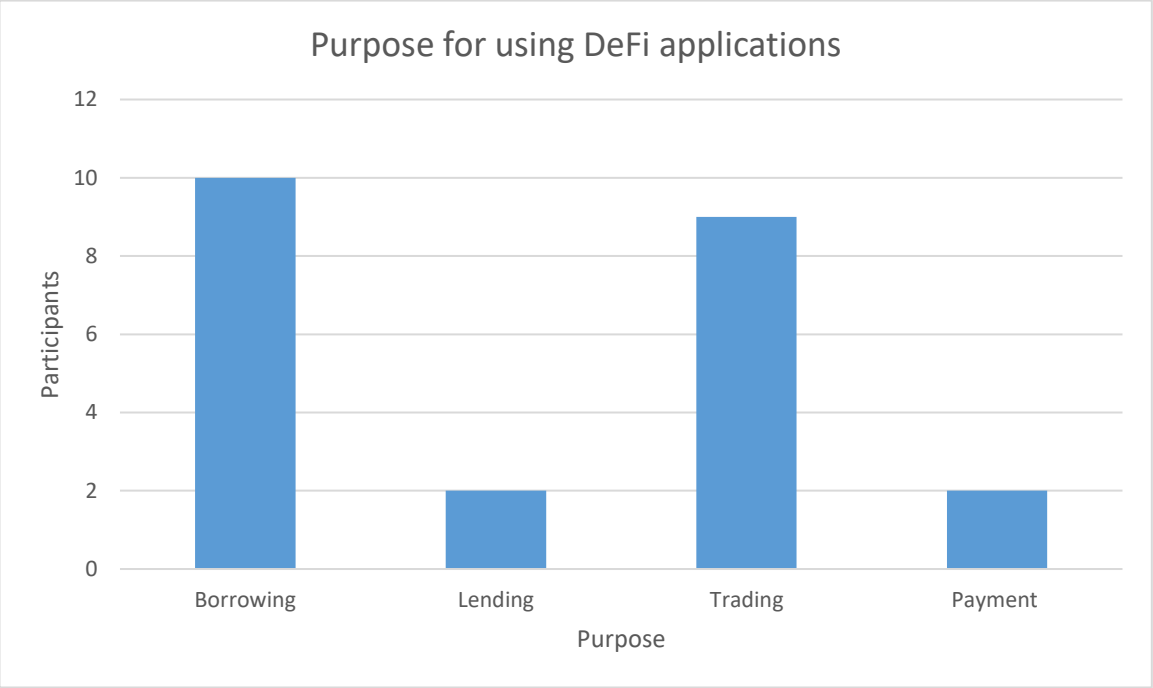

Chart 3. Purpose for using DeFi applications

The chart 3 shows the most common use of the application currently has been for lending the money. This is done by locking the valuable crypto assets on the smart contracts and in return getting the stable coin pegged to the dollar value for other use. This allows a person to use the money for other purposes without having to sell the crypto assets and in return lose the significant profit when the value of that assets rises in future. Trading was probably the first use of the decentralized application and it follows closely into the second place with emergence of derivatives and margin trading with the use of decentralised exchanges this could well be on the curve towards upward movement. Multiple answers were allowed in this question too.

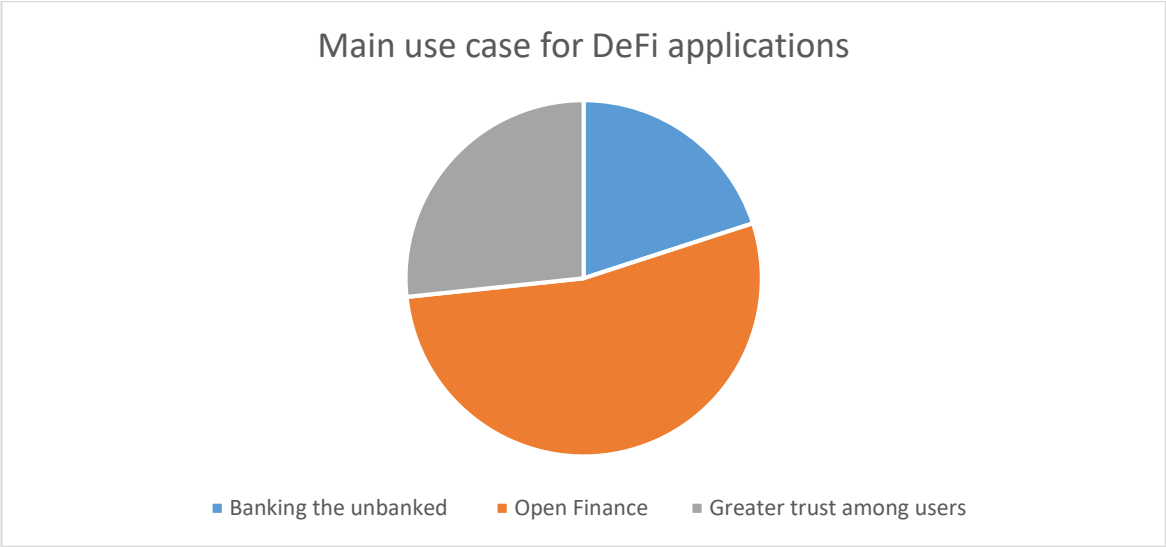

Chart 4. Participants reasoning for the use case of DeFi applications.

From the chart 4, Open Finance has been cited as the major reasoning for the use of decentralised finance application by the participants. This should not come as any surprise with the number of regulatory hurdle that a person needs to go through to use the traditional financial institutions. 27% of participants believes banking the unbanked as the use case for DeFi applications. With the amount of people who are not banked around the world DeFi could be the future of bank with its easy access to the money and also letting people from underdeveloped part of the world direct exposure to the major FIAT currencies like Dollar, Euro etc. which could potential be used to hedge their money on the time of financial turmoil and devaluation of the local currency.

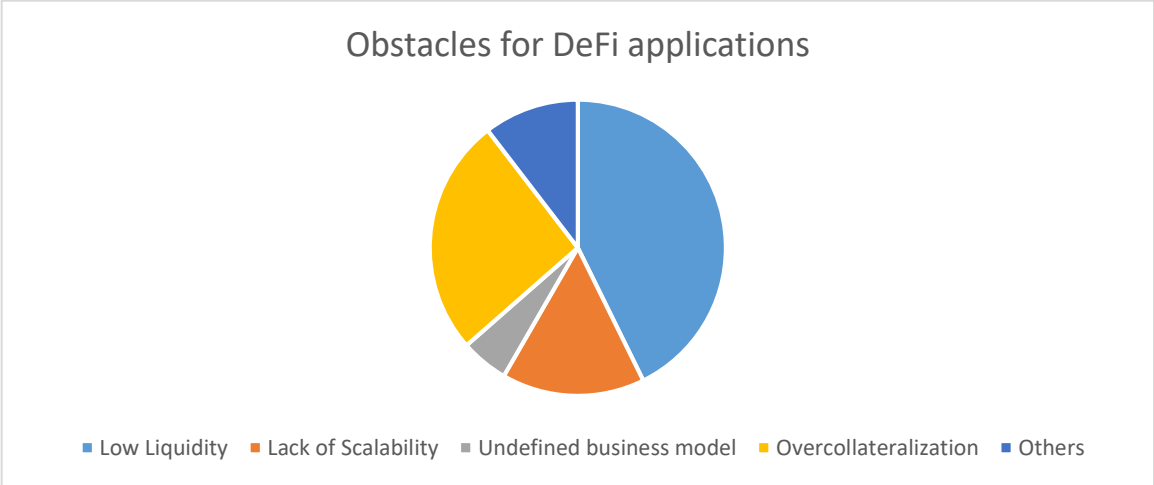

Chart 5. Obstacles for adoption of DeFi applications

Chart 5 gives us a boarder view of the respondent about the difficulties the DeFi based applications are facing for the mainstream adaption and competing against the established financial methods.

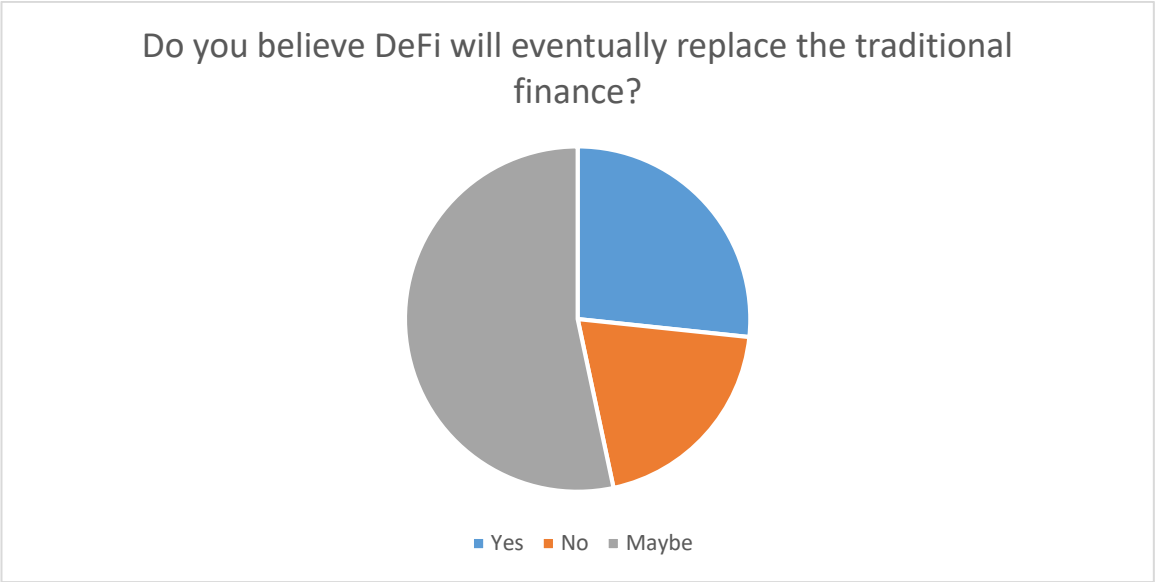

Chart 6. Respondent view on future of Decentralised Finance

Chart 6 shows the general consciousness among the early adopters about the decentralised applications and weather they believe the new method of finance is here to displace the long running model or here to co-exist with it and provide the alternate option.

From the chart 7 respondent views on the other application of blockchain technology beyond DeFi and Dapps can be evaluated. This chart shows the respondent belief that use cases will further beyond just the financial apps in the future.

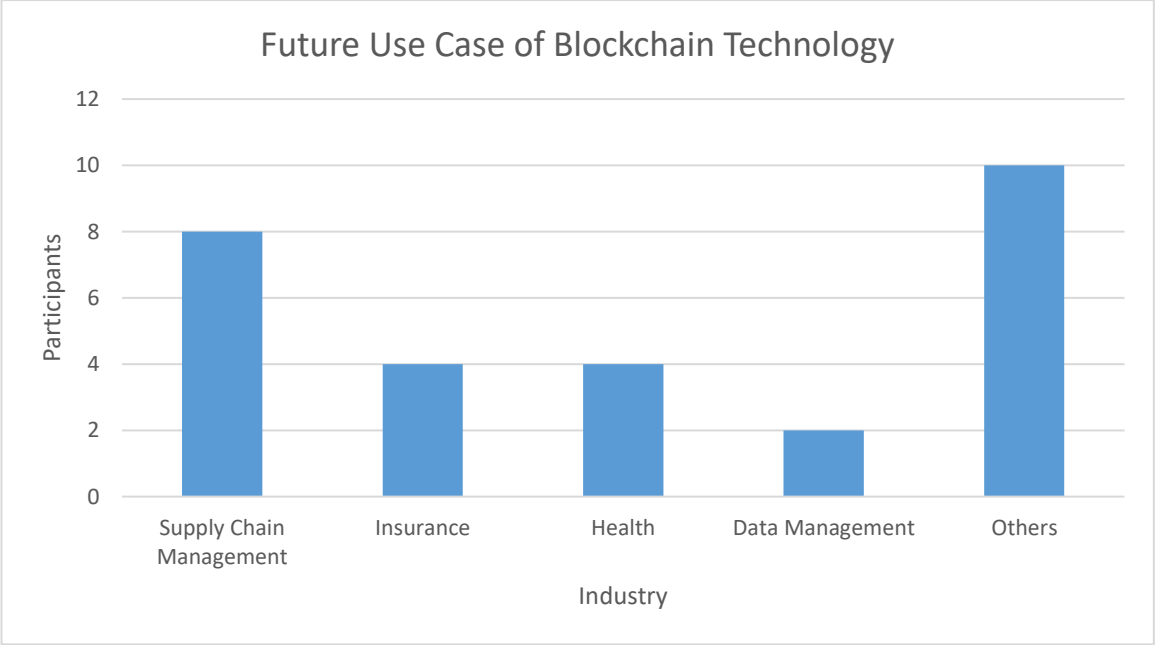

Chart 7. Respondent prediction of use cases emerging in near future.

4 Discussion

In the first research method dapps and DeFi applications data were obtained from the data providing websites mentioned above. I am going to divide this into two part as the DeFi applications will be analysed using the data collected from both method while the dapp will be analysed solely using the data gathered from the first research method.

4.1 Decentralised applications (Dapps)

Dapps are analysed on the basis of four metrics namely category, number of unique users, number of transactions and volume of transaction. Category helps to understand how specific field of use the dapps has penetrated and rest of the three metrics will help to understand the real time use of dapps.

There are 1769 Ethereum based dapps till the end of September 2019. They are divided across 9 different categories according to their use. From the Chart 1, we can see that Game, Gambling and High risk have the most amount of dapps currently on the market with Gaming dapps leading by the market share of 30%, High risk 24% and Gambling following them on third position by 21%. This is 65% of the all market share and exchanges, finance, social, arts, tools and other taking remaining 35%. Now comparing the data from the Chart 1 with table 4, we can corelate the amount of use of the dapps by the volume of transaction they are performing in first 3 quarter of the year 2019. Although the gaming has the highest number of dapps on market with the share of 30% their volume is on the very low side with the 99,028 Ethereum over the three quarter and putting them categorically on the last position among the analysed 5 categories. Financial dapps have grown rapidly over the three quarters and from not being tracked individually due to having low number in first quarter to ending the third quarter with 2,275,353 Ethereum. They have overall topped the combined transaction volume in this period. This is a major rise and shows the shifting change on the use of the decentralised applications and market trend of Decentralised finance (DeFi) based applications. Gambling is considered by many experts on the industry to be the first widely used use case of the technology. It seats on the third place on the volume over the three quarter. The growth in gambling-based application saw an increase from quarter 1 to the quarter 2 but a sharp declining of the use can be seen on the third quarter with the fall of around 80%. This can be associated with the rise of financial apps and people shifting their interest to more risk free financially beneficial products. Exchanges which are among the first dapps products are maintaining their position on the volume rank by being second with 2,418,235 Ethereum. This is the only

category which corelates the number on the market with the transaction volume on the chain with 24% of the dapps number and 29% of its volume.

The number of users of the dapps has grown quarter by quarter and stands at 1,761,369 at the end of September 2019. The total number of users has grown by 34.61% from the start of the quarter 1 to the end of the quarter 3. That's a significant amount of growth in the number of users with the number of active users more than doubling from 186,554 to 392,078. Rapid growth of active users points towards the increase in use of dapps over this period and rise in the general adoption among the end users. Although it shows the significant growth, the numbers are still on the very low side and incomparable to that of the traditional apps. Total number of main net address on the Ethereum has grown by over 16 million in last 3 quarters, the ratio of new address used for dapps has gone down from 1st quarter to the 3rd quarter. This shows that the growth in the use of Ethereum as a whole ecosystem but the growth of dapps compared at the same time hasn't been on the same ratio. Dapp user percentage has fallen from 3.7% to 2.31%. The end value is still an improvement in compared to the 2nd quarter where the decrement was much significant as it fell down to 2.09%.

Dapps users has grown steadily from the first registered dapp in May 2016. From the figure 6, we can see there has been a sharp increase in active dapp users in between two periods. First was in May of 2018 which coincidently happened in the same time of the phenomena known as Alt run in the cryptocurrency trading world. All coins or tokens traded on the crypto markets except of Bitcoin are known as alternative or alt coins. In this period of alt run, these coins grew in the value and weakened the market share of bitcoin. Most benefiting out on these runs were application-based platforms like Ethereum and the token based on the Ethereum based projects. Sharp growth of active users on dapps and decline coincides with the market movement of these coins on that same period. The dapp user's growth and crypto market growth has been proportional to each other ever seen. The decline in the value of the major crypto coins since the alt run of 2018 can also be seen in the number of active dapps user in the same period. The number of users picks back at the start of May 2019 with Bitcoin having an upward run on the market. As already mentioned above financial dapps grew significantly on the 3rd quarter of 2019 and we can see the correlation of that with the increase in number of active dapps user between august 2019 and September 2019. The general conclusion is the user activities have traded alongside the market sentiment. This could well change in the future with more and more dapps coming out that are beneficial in daily use. DeFi applications are leading this movement but there is a long way to go for it to compete with traditional application platforms like android and iOS.

The transaction of dapps have stayed above 5 million over the three quarters, with the peak of 6.04 million transactions over 2nd quarter. The transaction volume has increased by 400% from 202.22 million dollars in 1st quarter to 804.36 million dollars in the 3rd quarter. Since the amount of transaction in 1st and 3rd quarter aren't much different the growth is directly related to the increase of the Ethereum price in this period. Ethereum was trading at 135.15 US dollars at 1st of January and the value increased to 178 US dollar at the end of 3rd quarter in September 30, 2019. The Ethereum value topped at around 310 US dollar in July which played a huge part in the significant increment in the value of the transaction volume of dapps in 3rd quarter.

Some of the obstacles for the adoption of dapps I believe are mentioned below.

- The success of a product depends on the fine tuning the initial concept with the real feedback from the users. Dapps being decentralised from the initiation makes this a very difficult process. The steps that needs to be taken for the changes has to go through the governance model adopted and this makes it a very slow progress.
- The scalability of the blockchain is another major factor with the current available blockchains only able to do very small transaction per second. With the core process of dapps depending on the transaction and interaction with blockchain it's a major hurdle.
- Crypto market is very volatile, and it effects the user of dapps. As mentioned above how the volatility of the price of the platform (Ethereum) fluctuated the number of active users of the dapps. Stability is needed for the growth of the market.
- The usability and user friendliness are the biggest factor for the success of any products. On current level whole of blockchain industry including dapps are not user friendly. From the difficulty to understand the concept of long public and private keys to adjusting the value of the gas in moving the crypto assets the process is not easy for any layman user.

4.2 Decentralised Finance (DeFi)

The data were collected for this portion using both the research method used on this thesis. First research method was used to collect the data on top ten DeFi based applications and the amount of dollar value locked on them. Survey was conducted on the second method to obtain the various answers to the DeFi based applications, its uses and the future.

From the table 5, we can see the DeFi applications that are currently dominating the market. Maker DAO which a leading application platform on the DeFi world and it defines itself as “Maker is a smart contract platform on Ethereum that backs and stabilizes the value of Dai through a dynamic system of Collateralized Debt Positions (CDPs), autonomous feedback mechanisms, and appropriately incentivized external actors”. They run a stable coin called DAI backed by CDP. Ethereum was the only assets being used as collateral for generating of the DAI since its inception but that is about to change in the near future with the launch of Multi colateral DAI which is backed by multiple assets. They have 349.1 million dollar worth of assets locked in their smart contract and that has 102 million DAI generated and supplied on the market with the average collateralization ratio of 338%. This application also came out on the top used DeFi applications among the people surveyed with 8 out of 15 respondent having used it.

Lending platform leads the way among the top DeFi apps. 50% of the applications are based on lending and they have total of 534.8 million locked among them. 10 of our respondent of survey have used this platform to borrow the crypto assets in some way. Trading platforms has total of 135.2 million locked among them and duly stands on the second place in the use from the survey, 9 of the respondent are using decentralised exchanges for trading their crypto assets. Lightening network (LN) and wrapped Bitcoin (WBTC) are both related to the bitcoin. They are the only assets and payment platform among the top DeFi applications. Wrap Bitcoin is a bitcoin asset created on the Ethereum blockchain and is backed 1:1 by the value of Bitcoin. Lightning network is a payment system being developed to increase the scalability of bitcoin and perform larger amount of transaction per second to make bitcoin a viable peer to peer payment network. LN has 7.2 million locked value while WBTC market cap stands currently at 5.1 million.

Talking about the obstacles for the adoption for the DeFi applications, Respondents thought low liquidity to be the top concern. Majority of crypto market are traded at centralized exchanges, liquidity problem for the decentralized platforms are well known on the space. Contrary to the thought process that brought the existence of blockchain technology whose sole purpose was to create a decentralised system to overcome the centralised system, the dominance of the Centralized exchanges, marketplaces and lending platforms stands out like a thorn. This is directly related with couple of factors like scalability and usability of the decentralised products. Centralised platforms are much faster and ease of use makes it a first go to platforms for the majority of users. Interoperability is also the major issue with different blockchain platforms unable to interreact with each other. Cross chain trading between different platforms doesn’t exist on decentralised level and

the on-chain trade is limited within one platform among the assets or tokens created on it. These problems need to be solved to bring the liquidity present on the centralised platforms to the decentralised platforms.

Overcollateralization is second most voted issue among the respondents. This is very true for the volatile market like crypto. Overcollateralization is method used by many platforms to reduce the risk of the negative price movement to ensure the protection of the assets locked by the user to gain the loan. This does create a complain among the user because they have to lock significant amount of assets to gain the loan. Most users don't have that much funds and even the ones with fund it can be argued as the inefficient use of their capital. Less volatility is needed for the solving of this issue.

Undefined business model is another of the issue alongside the governmental regulations. DeFi being a completely new space that has come into prominence in last couple of years, business models that can be successful without hurting the investors and users are still on the process of being figured out. Regulation from governments will also come along the way as the space gets more exposure and it can potentially be an obstacle for the growth.

4.3 Oracle Network

I have used exploratory research to learn the advantages of the decentralised oracle network. Chainlink is the chosen oracle network in this portion as it is the most prominent in the space with their reach and partnership with major software companies like Oracles and many other major players within and outside of blockchain industry. Chainlink aims to build a fully decentralised network of oracles nodes compatible with all the blockchain available or on other word be a blockchain agonistic. Some of the use cases for decentralised oracle networks are mentioned below.

- Prediction market: A trust less access mechanism to the end result is necessary for the decentralised prediction market and distributed oracle has a part to play on it. (Garay 2018).
- Finance: Accessing the price of an asset or good needs a third party and oracle plays a role in here to provide those data. This is very important on some of DeFi applications which have stable coins pegged to the value of an asset. (Garay 2018)
- Identity: Blockchain based identity will come out as key for transparent and secure development of different process as the blockchain markets keeps maturing. Trust

less oracles are needed for the secure connection to identify the voters, medical patients or asset ownership. (Garay 2018).

The chainlink offers one in all platform for the data developers to create any type of oracle design needed for their smart contract. Chainlink offers the ability to decentralised both oracle and data sources. Some of the advantages they list of using their platform are listed below.

- Having multiple oracles(nodes) protects against the failure of single oracle through it going offline or getting corrupted by malicious attack.
- Decentralization of data sources gives an oracle opportunity to collect the data from different sources and aggregate into single data point to give the most accurate solution to the need of the requester. (Chainlink 2018)
- Chainlink has a reputation system for the nodes and are based on uptime, response time and successful completion of the jobs. This allows the requester to choose the best option available for them. (Chainlink 2018)
- Chainlink ensures the honesty on the system by using a deposit penalty system. This gives user a same protection like in centralised oracles where a private company providing the service can be held accountable for the misconduct. (Chainlink 2018)

4.4 Other use cases

From the chart 6, most respondent answer on which field the blockchain use cases might become prominent in the near future was supply chain management. I have done a small exploratory research to see the advantages it brings to the traditional system and the challenges on implementation.

Supply chains consists of networks of manufacturers, suppliers, distributors, retailers, auditors and consumers. Blockchain will help streamline the workflow for all these involved in the process. Implementation of blockchain technology brings traceability, transparency and accountability to the movement of goods and cuts down the cost on significant manner by making the business process more efficient. (Consensys 2018).

Some of the advantages it brings to the supply chain management are mentioned below.

- It enables direct communication without the need of the third party, this makes data transmission and interaction totally transparent. (Yurina 2019)

- Auditing cost is massively cut down with the auditor having access to the shared infrastructure where activities of the participants can be easily monitored. (Consensys 2018)
- Moving to the digitization solves lots of problem among the participants without having direct personal meetings. (Yurina 2019)
- Counterfeit products and fraud are among the major concern of the industry. Blockchain can transparently verify certification and coordinate record keeping immutability to prevent it from happening. (Consensys 2018)

Some challenges for the implementation of blockchain on supply chain management are mentioned below.

- Digitalization of supply chain management has been an issue from long time and many of involved people still work in a very traditional way with the use of pen and papers. Blockchain is a concept too far for them and trust factor remains very low.
- The rigid ERP followed by many companies doesn't suit the blockchain technology.
- Ecosystem is initial phase and like in every emerging technology changes are resisted at the beginning.
- Return on investment for the implementation cost is not there and technology needs to leap many level forward before it becomes viable enough for the companies to invest significant amount of money.
- Scalability of blockchain as in all other case is also a major concern.

4.5 Conclusion

To conclude this, I have decided to explain in briefly the research questions that were being focused during this research thesis. The purpose of the research was to examine the existing use cases of the blockchain technology and its penetration to the real-world use case. Research has shown that the blockchain has several use cases already in the market and has gone several step forward from just being a technology associated with the bitcoin. Although Bitcoin still remains the most well-known concept to come out of the technology, thesis has shown several use cases that have been trying to alter the way traditional market operate and make it more decentralised.

Smart contracts which brought the 2nd revolution on the field of the industry has given to the birth of concept like decentralised apps and decentralised finance. While the apps started to pop up as soon as first smart contract platform was launched, Decentralised finance which is trying to create the new wave on the financial market has started to gain

mass attention in last couple of years. Decentralised finance is leading the way of blockchain revolution and creating new asset class and the way to do business which will play pivotal way in the future of both blockchain growth and financial industry. Oracle is the linkage that is missing from the blockchain technology to connect with the real-world data. This is the final piece of jigsaw to bring the off-chain data on to the chain and to ensure the technology connects with the current business and helps in realisation of the true potential of decentralised future.

The obstacles are in multiple numbers like in every case when a new technology comes over and start the process to displace the current one. One major obstacle among all the use cases has been the scalability of the blockchain on the current form. The centralised system is much faster and safer for now when compared to the blockchain platforms available currently. The transaction speeds need to grow to perform high number of task it intends and ensuring the security of the network with the bad actor is also very necessary for the technology to get adapted. The cost of implementation and ease of use should go hand to hand, products based on blockchain technology needs to be more user friendly for an individual or a business to invest significant amount of capital to change the existing system.

Overall considering the industry is only like decade old and is trying to displace the system that has been placed for the ages, the progress made up to now is very positive. The obstacles are there to be concurred and building blocks are on place to achieve it. Markets need to get mature to give stability to the investors to provide capital and developers a less stressed environment to come out with the products to make the difference. There are still lots of technological, legislative and financial barrier to over come for the industry to gain mass adoption but there is no doubt of its significance over the long run.

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