# Technology Disruption and Blockchain: Understanding Level of Awareness and the Potential Societal Impact.

Dermot J. Bradshaw

Master of Business Administration

National College of Ireland

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# Abstract

Technology Disruption and Blockchain: Understanding Level of Awareness and the Potential Societal Impact. By Dermot J. Bradshaw.

This thesis paper looks at the disruption caused by emerging technologies in general, and by Blockchain specifically, to understand if society is aware of and understands the technologies and their disruptive impacts and if society is prepared for that disruption. The approach taken is to conduct a literature review and a web survey to gather the necessary data to address these points.

The paper begins with developing an understanding of new emerging technologies, presenting some examples from twelve technologies considered to have the most potential to influence society. Next, an understanding of Blockchain is presented, starting with its origin and working through to existing uses and potential future applications. Again, the societal impact is considered as the paper uses Blockchain to demonstrate technology's potential for societal disruption.

Understanding societal awareness of and preparedness for technology-driven disruption are this paper's main objective. The author presents evidence that society is aware of most of the emerging technologies, is even familiar with the concept of disruption, but does not fully understand the impact such innovations can have on their lives and on the their society. Finally, the author makes a series of recommendations for policy makers to take to prepare for the forthcoming technology-driven disruption of society. These recommendations are significant, requiring government oversight, but fully required to avoid increased social tension caused by increasing economic inequality.

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# List of Abbreviations

| | | |
|---|---|---|
| AAV | - | Autonomous automotive vehicles |
| AI | - | Artificial Intelligence |
| DLT | - | Distributed Ledger Technology |
| EU | - | European Union |
| GDP | - | Gross Domestic Product |
| GDPR | - | General Data Protection Regulation |
| GPS | - | Global Positioning System |
| IC | - | Integrated Circuit |
| IDC | - | International Data Corporation |
| IOT | - | Internet of Things |
| IT | - | Information Technology |
| MBA | - | Master of Business Administration |
| P2P | - | Peer to Peer |
| PRO | - | Public Relationship Officer |
| R&D | - | Research and Development |
| ROI | - | Return on Investment |
| STEM | - | Science, Technology, Engineering and Mathematics |
| TCP/IP | - | Transmission Control Protocol/Internet Protocol |
| US | - | United States |
| VR | - | Virtual Reality |
| WEF | - | World Economic Forum |

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# Chapter 1: Introduction

This research paper examines the disruptive impact of new innovative technologies on society in a general sense and, using Blockchain as an example, narrows down to the specific disruptive effect of such new technologies to understand if society is both aware of them and prepared to absorb that disruptive impact. As will be seen in the literature review, there are many examples of how society has had to deal with disruption from advances in technology. It therefore remains a relevant challenge for societies and their respective governments and policy makers today and worth studying to understand their awareness and preparedness.

There are three main objectives of this thesis paper –

1. Review the available literature to gain an understanding of disruptive technology generally and Blockchain specifically. Then, from this review, determine what potential disruptive impacts on society can be expected, both positive and negative.
2. Using the findings from the review, and the results of a quantitative web survey conducted on the topic of this thesis, to determine if society is aware of the forthcoming innovations and is prepared for the potential disruption they will bring.
3. Collate recommendations from the review and the web survey on possible courses of action open to companies, governments and societies to prepare for the inevitable technological disruption.

Throughout history, technological innovation has forced individuals, companies and societies to adapt and change, often on a disruptive scale, in order to succeed and keep growing. Failure to do so can have serious negative consequences for those entities that do not, or cannot, adapt.

There are many examples of disruption caused by innovation over history. Historically, they are grouped into the four global industrial revolutions. Schäfer (2018) describes the four, detailing how they affected society. The first industrial revolution, which took place primarily in the nineteenth century, saw the introduction of machines powered by steam, which produced significant increases in

labour productivity. This resulted in societies evolving from being almost completely agrarian to heavily manufacturing focused and resulted in the mass migration of people from the countryside into cities, changing forever the course of humanity.

The second industrial revolution took place a century later with the introduction of electricity further improving human productivity on a massive scale paving the way for "individualised mass consumption". The third industrial revolution took place in the mid-to-late twentieth century with the introduction of information technology and, especially, personal computing to the world.

Today, with the start of the fourth industrial revolution, also known as the 'Digital Revolution', innovators are building upon the third revolution's digital advancements to develop such wonders as robotics, artificial intelligence, virtual reality, robotics and Blockchain, to name just a few.

Each new industrial age saw the introduction of emerging and innovative technologies that hugely impacted on societal development, for better, and perhaps sometimes, for worse. An important difference between innovative development in the past and developments today, as pointed out by Del Rosal (2015) in his book *Disruption: merging technologies and the future of work,* is that innovation is happening much quicker than for earlier generations, with developments occurring at an exponential rate. The inference is humanity will experience disruption at the same exponential rate. The question is therefore, is society aware and is it prepared?

Technology disruption and its potential impact on society is now an international concern. As reported by Goodwin (2017) in Computer Weekly, one of the main topics on the agenda of the World Economic Forum (WEF) 2017 meeting in Davos, Switzerland was the potential disruptive impact of emerging technologies on society and how unprepared society and governments are to deal with them. For example, the same article quoted that 45% of jobs today could be replaced by automation if companies wished. Imagine the societal impact 45% unemployment would have.

Davis and Philbeck (2017), in their contribution to the WEF's 2017 Global Risks Report, also highlight the disruptive impact of emerging technologies. They map out twelve technologies, listed below, requiring serious consideration by governments

and regulatory bodies to ensure resultant societal impact will be managed carefully and appropriately. The example of autonomous vehicles is a case in point. If self-driving cars are much safer than cars people drive, then is comprehensive insurance required at the same level? If not, the impact on the motor insurance industry, including those employed there, could be significant.

Davis and Philbeck (2017) listed twelve major emerging technologies that have the potential to dramatically impact society. Looking at both the benefits of these new technologies, and their potential negative consequences, Davis and Philbeck (2017) devised a grid to plot the expected impact as shown in Figure 1.

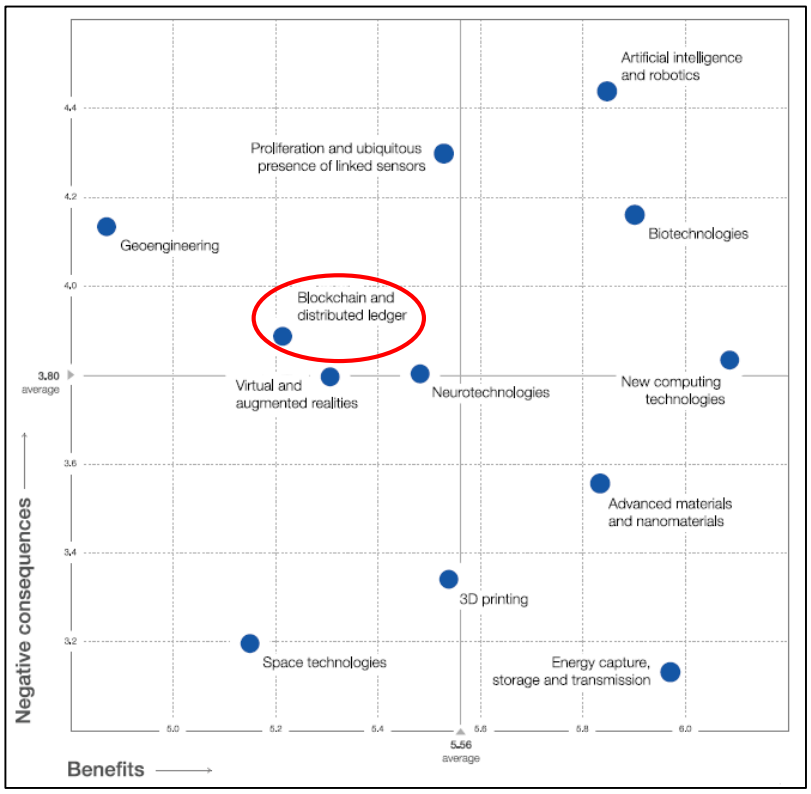


Figure 1 – Perceived Benefits and Negative Consequences of 12 Emerging Technologies

*Source: Davis and Philbeck (2017) The Global Risks Report, WEF: p44*

Blockchain, or distributed ledger, circled in red in the grid above, is recognised as an emerging but potentially disruptive technological innovation. However, what is Blockchain?

Blockchain is a distributed ledger technology (DLT) that provides users with a secure and transparent way of recording, transacting and tracking any digital asset. The first

major use of Blockchain was for the cryptocurrency Bitcoin, the best known digital currency, which was created by the entity known as Satoshi Nakamoto in 2008 (Nowiński and Kozma, 2017). However, it soon became apparent that Blockchain technology could be put to other uses and so it became an emerging technology of great import in its own right. A number of examples of those alternative uses is shown in Figure 2.

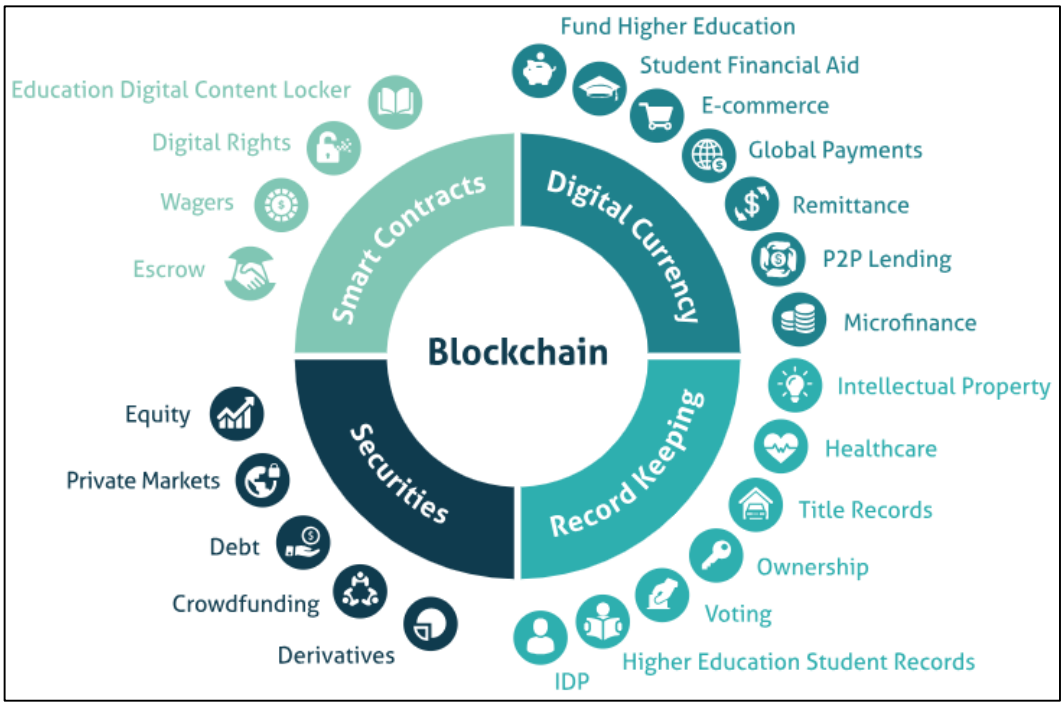


Figure 2 – The Potential Applications of Blockchain
*Source: FAHM Technology Partners website*

Tapscott and Tapscott (2016) refer to Blockchain as a global distributed ledger "of economic transactions" that can record and track nearly all items of value. Underwood (2016) talks about the potential for Blockchain to "empower people in developing countries with recognized identity, asset ownership, and financial inclusion" and that this technology has the potential to allow for the handling of a financial crisis similar to 2008 much more effectively. A majority of Blockchain authors agree that Blockchain has the potential to be as big a game changer as the Internet.

This research responds to the heightened attention of Blockchain as a disruptive technology affecting companies, industries and societies, such disruption having the potential to be significant. This author will undertake to demonstrate this using

Blockchain as an example, attempting to determine if those impacted are aware of the potential forthcoming disruption and are prepared and, if not, what needs to be done to prepare.

This introduction presented an overview of the topic of disruptive technology and Blockchain. What follows is a literature review and presentation of the research question. A discussion of the methodology is then offered followed by the findings and analysis from the research instrument, where links from the findings and analysis to the literature review are identified. Finally, limitations of the research and guidance for further research opportunities is covered in the concluding chapter of this project.

# Chapter 2: Literature Review

This chapter reviews what is meant by disruption to societies caused by emerging technological innovations. Specific examples are reviewed to give the reader a clearer understanding of how that societal impact manifests. The review will then narrow in on Blockchain technology and its potential societal impact, beginning initially with gaining an understanding of Blockchain, followed by what it can potentially do in terms of societal disruption. The chapter will finish off with possible steps that may be taken to prepare society for disruption caused by emerging innovations generally and for Blockchain specifically.

## 2.1 Understanding Technology Disruption

In chapter 1, technology disruption is presented as a common theme, one evident throughout the course of humanity's development in various ways. There are many examples of this, from the development of steam power trains in the first industrial revolution through to the mass rollout of electricity to all members of society in the second; technology disruption has continually helped society evolve to what can be seen today, for better or worse. Moreover, this trend appears likely to continue in the fourth industrial revolution in which we now find ourselves.

Moore's Law (Moore, 1965), named after Gordon Moore, the co-founder of Intel who first put forward the concept, states that the number of components per integrated circuit (IC) will double every year. The implication is the processing power of ICs will also double making all electronic devices correspondingly faster and more powerful. Moore (1975) revised his estimate a decade later to a doubling every two years and this has remained reasonably accurate to date and should continue for another decade at least. It is the main reason why technology is innovating at an exponential rate and is developing such a disruptive potential.

The first and second industrial revolutions took approximately 100 years each, with developments over that 200 years happening with slowly increasing regularity. However, in the third industrial revolution, which took just over 40 years to run, developments occurred with ever increasing regularity and that trend of exponential innovation is continuing into the fourth industrial revolution. Figure 3 illustrates this below.

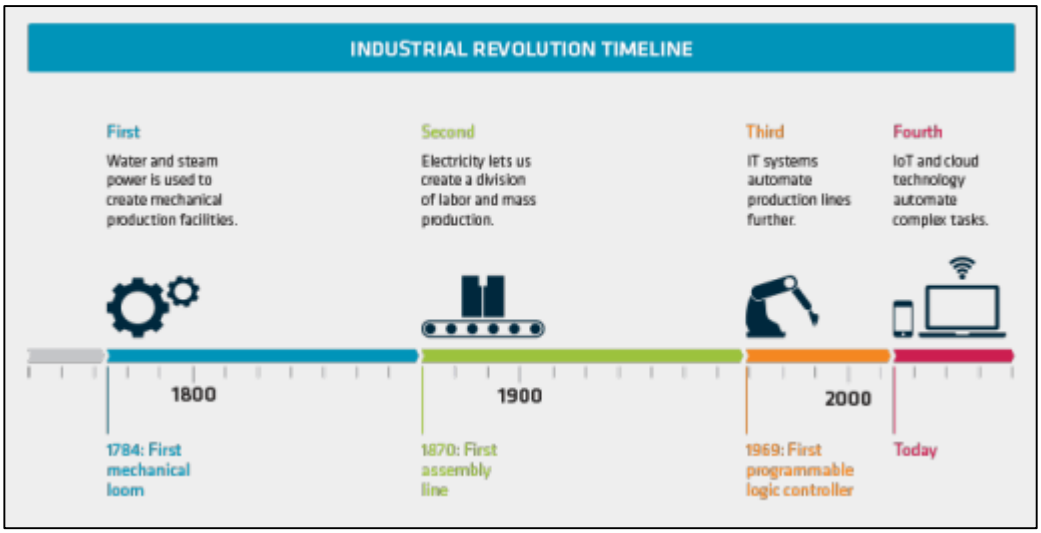


Figure 3 – The Four Industrial Revolutions
*Source: PWR: work&labour news&research website*

Schäfer (2018), in his paper on the fourth industrial revolution, does focus on how the European Union (EU) can take advantage of it, but he also makes quite pertinent points about the unprecedented speed on technology innovation being experienced today. Schäfer (2018) makes the point that the fourth revolution's technological advancements are generating "enormous economic benefit". However, he also raises some concerns for the working population and consequently, governments, about the impact it will have on peoples' lives. Schäfer's reasoning for this is that the speed of innovation is resulting in people not being able to keep pace with technology advancements. Parts of humanity are becoming "dislocated not only technologically but also in economic and social terms" (Schäfer, 2018).

Klaus Schwab, the Founder and Executive Chairman of the WEF, reinforces this point in his paper 'The Fourth Industrial Revolution: its meaning and how to respond' (Schwab, 2017). In it, Schwab details both the benefits of technology innovation and the perils to watch out for. His point is talent will become more important than labour generally, meaning the gap in society between the high-skill / high-paid sectors and the low-skill / low-paid sectors will further increase thereby increasing social tensions. Schwab (2017) views this social fear as "the greatest societal concern associated with the Fourth Industrial Revolution".

Even back in 2012, Brynjolfsson and McAfee (2012), in their eBook, Race Against the Machine, identified the accelerated pace of technological development as the reason

the average gap between family income and companies' productivity has continued to grow since the 1980s. Their attention was drawn to the fact that, after the 2008 financial crash, median family incomes have steadily fallen while companies have recovered from the crash relatively quickly and are showing notable increases in labour productivity. In their book, Brynjolfsson and McAfee (2012) remain optimistic that the advancements made from emerging disruptive technologies will be more positive in their impact on society than negative. However, this will only be the case if there is a global change in organisational structures, to focus more on innovation, and massive investment in human capital so that people can receive the skills required to succeed in this new technological world.

Brynjolfsson and McAfee (2012) are not alone in their findings. Eberhard, Podio et al (2017) get quite specific on potential impact. Based on their research, it is estimated by the year 2033, "47% of all jobs in advanced economies are at high risk of automation". Their reports identifies some areas that are impacted by advances in robotics, digitalisation, artificial intelligence and other emerging technologies that are forcing automation and "substitution of human workforce". Those areas include logistics, law, healthcare, accountancy, patent law, to name a few. It is pertinent that these are industries not typically threatened by automation and therein lies the conundrum for companies, governments and societies; traditional white-collar, middle class roles will slowly be replaced by advanced technology.

## 2.2 Specific Potential Impacts of Emerging Technologies

So far, the review of technology disruption has been in general terms. To better understand how such disruption affects societal entities, it is necessary to look at specific examples. Only then can one begin to understand how disrupting emerging technology might actually be. In addition, disruption caused by multiple technologies together should be considered, referred to as the Lego building-block approach by Gomber et al. (2018), rather than just the impact of a single emerging technology.

Reader please note, due to the size and time constraints on this paper, it is not possible to cover all disruptive technologies. That said, those covered will give the reader an understanding of how technology innovations can disrupt industries and societies.

### 2.2.1 Artificial Intelligence and Robotics / New Computing Technologies

Richard Weber (2017), in his paper 'Resistance Is Futile; Disruption Is Inevitable', takes a brief look at how the automotive industry may be disrupted by automation and artificial intelligence. Weber (2017) begins by informing his audience of a collection of pertinent statistics such as –

- 1.25 million people died in traffic-related accidents in 2015.
- The average car is used less than 5% of its owner's time.
- $14,000 is the average annual running cost of a 'nice' car in the United States (US).

Autonomous automotive vehicles (AAV), driverless cars, began with an Uber initiated pilot test in two locations in the US last year. (Both locations had a driver in the driving seat just in case of mishap). Considering some traditional automotive manufacturers, such as General Motors, BMW, Tesla and Audi, are investing in AAVs (Weber 2017), it is fair to assume the technology will reach the point of being truly autonomous. The obvious question then is what happens to those who made their livelihood as Uber / taxi drivers?

Consider that AAVs will also be able to communicate with one another and with surrounding road control infrastructure, making them much more efficient at regulating traffic, it is estimated the number of road deaths and accidents will drop considerably. Goodwin (2017) quotes the view of Richard Samans, a member of the WEF managing board, that in the US alone, the number of deaths from automobile accidents will drop from an average of 40,000 per year to 20,000 per year, which would be considered a welcome development of a disruptive technology. However, one must also consider the litigation impact and role of insurance companies.

Samans (Goodwin, 2017) considers this a challenge to the Insurance industry. For example, in the event of a serious accident involving an AAV, and the aggrieved party wants to sue, whom do they sue? There is no driver, so do they sue the car owner, the car manufacturer or the software provider? In addition, do AAVs need the same level of insurance if the rate of accidents drops considerably? What impact would

that have on the Insurance industry? Not necessarily a bad thing, but something those in the insurance industry need to consider.

Now consider the second bullet point above, that a car is used around 5% of the time. Weber (2017) details how some major automotive manufacturing companies are considering a complete paradigm shift in how people use cars. Rather than owning one, users would order a private or shared car via a Blockchain-based mobile application, use they car for when they need it and release it for the next customer. Weber's (2017) question is what does this mean for automotive manufacturers? Would it increase automotive manufacturers' sales or reduce them. With the move to electric cars, would the pick-up and drop-off points be at charging stations? This is an example of multiple technologies being involved.

### 2.2.2 Proliferation and Ubiquitous Presence of Linked Sensors

The Internet of Things, along with ubiquitous internet connectivity, is another area where one can expect significant innovation and consequent disruption. Del Rosal (2015) refers to the IOT as a "network of physical things that contain embedded technology to communicate and sense or interact with their internal states or the external environment". What this means is devices such as automobiles, home appliances, user wearables and other non-traditional electronic devices connected to the internet will be remotely monitored or controlled and possibly interact with other connected devices.

Hsu and Lin (2016) quote an International Data Corporation (IDC) estimate that the IOT market will hit $7.1 trillion by 2020. In addition, within the same timeframe, in terms of devices connected, they quote a Gartner estimate of 26 billion connected IOT devices. Clearly, it is an area to be given serious consideration.

However, what does the IOT mean to the average person? Today, one can have a wireless thermostat / boiler control installed in their house. This would allow, for example, homeowners / residents to turn on the heat from work so they can come home to a warm house on a cold day. You could have most of your home appliances connected to the internet so they may be controlled remotely. You could turn on your wi-fi connected lights when out of the house to deter intruders. You could have

a wireless camera in your doorbell so that if anyone calls, you can see who is there and talk to him or her. You could even have an automatic lock to open your door if you are happy to do so (Staggers, 2018).

A well-known IOT example is having an internet-connected fridge that can tell when you are out of any particular food items and order them for you. You might even have a camera in the fridge to see what is there via an app on your mobile whilst at the supermarket, preventing you from over-purchasing. The point is, the possibilities are immense and the surface has only just been scratched.

Now apply this potential to an aging society such as Japan or even Western Europe. Demiris and Hensel (2008) introduce the concept of building 'smart homes' filled with connected devices to aid older residents. They provide some interesting examples of IOT devices that provide such services as functional monitors that watch out for potential falls or safety monitors that can detect, for example, carbon monoxide or other gases, and can send for help is anything is detected. You could even install monitors in the toilet to measure bladder and bowel output. Distasteful perhaps but important for older generations. IOT devices could help improve social interaction or even provide assistance to those with deficient sight or touch, etc.

Another healthcare-type of IOT device can be seen in use today almost everywhere. Smart watches have become very popular throughout the world with many companies such as Apple, Fitbit and Garmin developing devices. Most of these wearable devices have a number of functions, but critically they have sensors that can monitor heartbeat, number of steps, sleeping patterns, distance walked, run or cycled and so on. Consequently, linked to smart mobile cloud-based applications, terabytes of health-related data is being collected on peoples' life-styles. This author has personal experience of an acquaintance noticing irregular heart rhythms being recorded on their Apple Watch and attending a physician as a result. That acquaintance ended up on heart medication for life, having just avoided a potential life-threatening heart-related event.

All the above benefits are quite evident and make a great advertisement for IOT devices such as wearable technology. However, despite the benefits identified, IOT

devices present challenges in the area of data ownership, data jurisdiction and data privacy, particularly pertinent since the introduction of General Data Protection Regulation (GDPR) on May 25, 2018 (European Union, 2016). This is a concern one will encounter across the emerging technology spectrum. Ghazinour et al (2017) identified this in their paper 'A Model to Protect Sharing Sensitive Information in Smart Watches'. The challenge is there is a plethora of data on a user's health and the user has limited control over giving their approval on what is shared and what is not, where it is stored and how data protection is guaranteed. The model suggested by Ghazinour et al (2017) recommends allowing user preferences at a much granular level. That is, sharing specific aspects of stored data, e.g. heart rate data, without having to share it all.

The next consideration is then what should the model look like if the smart watch is provided free by one's health insurer; can the insurance company use the data to set insurance premiums? One insurance company, Vitality, has already developed products to analyse biometric data from users' smart watches to customise their health insurance cover. (Golia, 2017). Alternatively, what if your employer supplies the smart device; can the company use the built in Global Positioning System (GPS) to track your movements? One can understand why government regulators are beginning to give emerging technology serious attention.

### 2.2.3 Virtual and Augmented Realities

Another interesting emerging technology with disruptive potential is Virtual Reality (VR). Del Rosal (2015) defines VR as a "computer-generated simulation of a 3-D image or environment, in which interaction takes place using special electronic equipment such as helmets and gloves". With the right access accessories, it is possible to immerse oneself fully in a virtual environment. How is this of benefit to society or where does the disruption happen?

Take an education setting for example. Traditionally, when one attends school or college, one physically goes to a classroom within a school building. Even so-called online courses involve a lot of 'study-on-your-own' effort with the odd irregular gathering of students. In a VR environment, neither the teacher nor the students

need to be in the same place, or even the same country, as the teacher. With the right tools, a class can gather together for a lesson in a virtual environment.

The same principle can be applied to the workplace. You could attend a very important management meeting while sitting in your shorts on the beach. An exaggeration perhaps, but the principle is sound. The potential implications are significant. Would physical school buildings still be required? Are larger classes possible and, if so, how does one control the students? Does that mean as many teachers are required or would it allow more teacher specialisation allowing for higher quality teaching. Then how does one make up for the lack of social interaction all humans require?

## 2.3 Blockchain

### 2.3.1 Background and Context

As shown above, Blockchain is an emerging technology with the potential to cause serious disruption in a number of industries. The intent here is to demonstrate the potential disruptive effect an innovative technology can have using Blockchain as an example. The approach will be to define Blockchain, understand what it can do by looking at existing applications and then look critically at what the future might hold for it.

Whilst Blockchain is relatively new, it is a technology grabbing the attention of many industries and businesses around the world. The reason for this is the recognised potential for significant disruption is quite real (Hackett, 2017) and these entities wish to protect themselves. However, it not just the disruption to industry and businesses that is interesting, it is the current and potential impact on society as a whole that is most intriguing. Blockchain has the potential to "reconfigure all human activity as pervasively as did the Web" (Swan, 2015).

Blockchain, which is more of a colloquial name, is a "shared, distributed transaction ledger that records all transactions and operates through the Bitcoin protocol" (Cusumano and Nakamoto, cited in Subramanian, 2018). At least that is how it began. Swan (2015) goes a step further by breaking Blockchain down into versions or generations. Version 1.0 (v1.0) for Cryptocurrencies, v2.0 for Smart Contracts and v3.0 for applications beyond those developed by and for the financial services

industry, especially in the areas of government, science, health and art to name a few. One might argue that due to the quickly evolving understanding of Blockchain and its potential, these classifications will be overtaken. Nevertheless, they are a useful mechanism for focusing attention.

### 2.3.2 Bitcoin

As stated above, Satoshi Nakamoto's Bitcoin was the first public manifestation of Blockchain. The Bitcoin Blockchain is essentially a "chain of digital signatures" (Nakamoto cited in Nowiński and Kozma, 2017), a series of blocks each representing a specific transaction. Each transaction, for example a Bitcoin transaction, is registered, time-stamped and published to all network participants, known as nodes, with a unique symbol.

Because of its decentralised approach, Blockchain is unique in that it removes any single-point-of-failure events and can prevent a single centralised entity (e.g. company or government) controlling and "manipulating a shared central database" (Subramanian, 2018). Subramanian (2018) goes on to detail the characteristics that allow it to achieve the above: -

- Validity – there are no fraudulent or duplicated transactions in a Blockchain as all transactions are made unique through "timestamp-based validation".
- Persistence – All transactions relating to a traded asset are publicly available and verifiable on the distributed ledger.
- Privacy – All transactions are automatically encrypted and so the details can remain hidden and protected until made available by the asset owner.
- Traceability – Transactions can be traced back to both sender and receiver, which puts the minds of regulators at rest by assuring them that illegal acts such as money laundering can be detected and dealt with.
- Immediacy – Transaction validation always takes the shortest, and so quickest, route thereby enabling instant validation through "proof-of-service, consensus and proof-of-stake".

Lou Carlozo (2017) backs up Subramanian's view and adds to it with the view "Blockchain is secure and immutable". That is, it cannot be hacked without gaining

control of all the computers, or nodes, that contribute to and update the distributed ledger. This point is especially important when considering Blockchain's impact on society.

### 2.3.3. Cryptocurrencies

Before we can consider the societal impact of Blockchain though, it is important to have a grasp of cryptocurrencies, or Blockchain 1.0 (Swan, 2015), as Blockchain began with Bitcoin and the cryptocurrency concept is potentially a major societal disrupter itself. Theoretically, cryptocurrencies could supplant fiat currencies (Dollar, Euro, Sterling, etc.), or offer a way for currencies in the future to go fully digital. Beginning here allows one to comprehend why Blockchain is bigger than cryptocurrencies and has the potential it does.

Heaven (2017) suggests there is a very real possibility that fiat currency replacement will eventually happen. Even though it is early days, there is already a 'civil war' between two Bitcoin factions, those who believe Bitcoin should remain available to all as Nakamoto intended, and others who believe Bitcoin should facilitate more transaction types and so be able to begin to compete with the likes of PayPal and Visa. This split has resulted in the Bitcoin Cash cryptocurrency in addition to the original Bitcoin.

Satoshi Nakamoto's Bitcoin was the first, but is by no means the only cryptocurrency. There are many in existence today, Ethereum, Ripple and Litecoin being three of the more popular ones. The point is that cryptocurrencies are not like fiat currencies in that they are not physical, but virtual, nor are they controlled by a central authority like a Central Bank or Federal Reserve, but by a global distributed ledger of peer-to-peer network nodes (Tapscott and Tapscott, 2016). The lack of a requirement for a central entity, referred to as disintermediation, is an important point particularly when it comes to societal impact as will be demonstrated later.

Currently, there are in excess of 1,300 different cryptocurrencies available to trade or use for various purposes in the world today (CryptoCompare, 2018). At this stage in cryptocurrency's evolution, there is not much commercial activity taking place with them. That is still the domain of fiat currencies, but it will change. This is partly

because, at this time, cryptocurrency values are non-regulated and can fluctuate wildly making them an unstable artefact with which to trade (Chohan, 2017).

Various regulatory authorities are concerned about the growth of cryptocurrency activity, especially regarding the decentralised nature of it, and are considering how best to regulate (Hughes and Middlebrook, 2015). That said the counter-argument to such oversight is that the nature of how cryptocurrencies operate on the Blockchain make regulation redundant (Chohan, 2017). Nonetheless, intermediation might be pertinent to cryptocurrencies more so than to other Blockchain assets if they are to gain acceptance as a stable marketplace currency (Harwick, 2016).

### 2.3.4 Disintermediation

The biggest potential of Blockchain is its potential to remove intermediaries, the aforementioned disintermediation, from the marketplace altogether thereby causing market disruption on a scale similar to the introduction of the internet (Tapscott and Tapscott, 2016) and this is where the impact on society has to be considered.

As stated above, the characteristics of "Blockchains are particularly well suited to situations where it is necessary to know ownership histories" (Boucher, 2017). For example, it can help combat online piracy of music, movies, books, etc. by facilitating the legitimate trading of digital media. Raine (2017) provides some insight into work already taking place in this area, and some challenges faced from within the music industry. There are two main Blockchain points of view alive in the music industry today. Those who want to use Blockchain as a disrupting technology to facilitate "more direct artist-to-consumer engagement and commerce" and to remove intermediaries (disintermediation) such as record labels, publishers or Public Relationship Officers (PROs), and those who want to use Blockchain to make the existing industry more efficient and transparent. Raine (2017) details an approach being taken by an initiative called Dot Blockchain Media (dotBC). dotBC is developing a new file format, called .bc, using Blockchain. The intent is for .bc to replace the .wav and .mp3 file formats as the standard music file format in the industry. The .bc files, existing on a Blockchain accessible to all in the music industry, would contain audio files and smart contracts associated with all music. That Blockchain then becomes a one-stop-shop for transparently controlling ownership rights and royalty

payments. The hope is this would assist in avoiding the confusion that is rife in the industry today.

### 2.3.5 Supply Chain Application and Smart Contracts

Blockchain can make managing supply chains much more efficient allowing, for example, the purchaser of a diamond to know if it is ethically sourced and not a conflict diamond (Boucher, 2017). Roberts (2017) expands on this point with the example of the company, Everledger, who has developed a Blockchain for recording specific details of 1.6 million diamonds such as carat, colour and certificate number. This allows interested parties to confirm the provenance of a specific diamond including knowing how it was sourced. Everledger is also adding others luxury items to its Blockchain. For example, fine wines with hidden codes added to the bottle allow consumers to validate the authenticity of that expensive bottle of wine they procured. Everledger already have a target of users being able to validate the provenance of any of their logged assets from an app on a mobile phone.

Raza Pirbhai (2017) discusses how Blockchain has revolutionised the social processes because of its characteristics of transparency, accountability and security. As Blockchain ledgers are open and transparent, shutting down any computer node on the chain will not result in a loss of information as each node has a copy of it. Expanding on this, Benchoufi and Ravaud (2017) explain how the decentralised and secure "trustless" nature of Blockchain lends itself to "securely automating the clinical trial process through what are called Smart Contracts". In this context, trustless means the element of interparty trust is not required as trust is hardcoded into the Blockchain protocol via complex encryption algorithms. In addition, a smart contract can be defined as a "computerised transaction protocol that executes the terms of a contract" (Szabo cited in Boucher, 2017).

Bridgers (2017) uses the example of how a smart contract might be used in a human resources context by validating in an employment contract "that an employee has the requisite qualifications for the job". The big savings for companies is that smart contracts can be coded to auto-validate the terms of the contract thereby saving in labour and legal costs.

### 2.3.6 Industry Disruption

Further elaborating on the impact on the area of legal, the research conducted by Fenwick, Kaal and Vermeulen (2017) into the impact of disruptive technology, with specific mention of Blockchain, on the Legal Profession is sobering for those in that profession. Fenwick, Kaal and Vermeulen (2017) believe, particularly with Blockchain, that Law Schools need re-invent themselves and "raise awareness of the opportunities" such innovative technology can provide allowing them to prepare the legal industry and its clients for significant disruptive change.

Bridgers (2017) provides another example where disruption to an existing industry could occur. The 'ride sharing' company Uber, itself a company that used technology to disrupt the taxi industry, currently matches drivers they have 'aggregated' with customers who need a lift. Using Blockchain, the user could communicate with the driver directly to request the service. The details of both the requester and the driver are on a relevant Blockchain and can be authenticated, removing any trust issues between the parties'. This would obviously be a threat to Uber's business model and the same can be applied to other aggregating intermediaries such as Airbnb.

### 2.3.7 Digital Identity and Food Safety

Food safety is another area where Blockchain can play a significant role, especially for those elements of global society that might struggle to prove their identity, e.g. refugees. Accenture, IBM and the United Nations are collaborating to build such a Blockchain (Hackett, 2017), helping refugees who do not have official documents. This approach could be used throughout the world, giving true ownership of one's identity back to the individual rather than it being held by a company or Government entity.

Even when the Blockchain development effort is company driven, it can benefit society. Consider food traceability, what Walmart's Vice President of Food Safety Frank Yiannas calls the "Holy Grail" (Hackett, 2017). Yiannas was concerned about how long it would take to track the source of a foodborne illness, should one arise from one of their food products. Walmart worked with IBM to build a Blockchain for tracing their mango slices from a Mexican farm to a Walmart shelf in the US, reducing

the amount of time required to identify the source of the product from nearly 7 days to 2 seconds. Such an efficiency gain could literally save lives.

### 2.3.8 Fighting Corruption, Expanding the Global Market and Climate Change

Underwood (2016) details examples that address the fact that an "independent evaluation group of the World Bank says 70% of the world's population lacks access to proper land titling or demarcation". Not being able to assert identity and ownership of property that could be used as collateral prevents this large section of society from accessing financing via bank loans, etc. which, in turn, prevents them from setting up businesses and contributing to their local economies. In response to this type of issue, the National Agency of Public Registry in Georgia is working with a Blockchain development company called BitFury to pilot a project to use secure distributed ledger records to manage land titles, reducing registry fees by 95%, increasing transparency of land ownership and reducing fraud and corruption in that area. This can be considered a positive disruptive effect in societies challenged with corruption.

Another such example is taking place in Honduras where a company called Factom, partially funded by the World Bank, are storing property titles on a Blockchain. According to Mariana Dahan, senior operations officer at the World Bank, this allows, for the first time for most participants, the lower socio-economic ranks of society to "assert reliable title claims to their homes and use them as collateral for borrowing" (Underwood, 2016). Not only are such undertakings good for the participants' local economy, but also for the global economy when you consider the 2 billion plus who could gain access to real funding for the first time.

It is not just directly that society's members can benefit from Blockchain, but also indirectly. Take the threat to the environment due to climate change. The Paris Climate Agreement, in which nearly all of the world's countries are participating, requires all signatories to reduce the carbon footprint of their jurisdiction. Progress against the objectives laid out in the agreement is measured by carbon emission levels. Carbon credits, which put a price on carbon reductions, can be traded to offset the impact the decisions of countries and companies on their own local environments. However, this process is not very transparent or trusted which is

where Blockchain comes in. With Blockchain, it is possible to create a virtual 'carbon currency' to bring transparency to carbon credit trading and consolidate the carbon market so it can scale up to a global level. "Carbon credits are the perfect candidate for a digital currency as they are data-driven, rely on multiple approval steps and exist separately to the physical impacts to which they correlate" (Walker, 2017).

### 2.3.9 Cautiously Optimistic

Despite all the positives mentioned above, it is still very early days in the evolution of Blockchain. There are many challenges to overcome to bring the technology into the mainstream. As an example, Cachin (2017) makes the point that many claims are being made regarding how safe the cryptography of the Blockchain is. The claim is easy to make though. "Expert judgment, formal reasoning, experience, public discussion, and open validation are needed for accepting a cryptosystem as secure" (Cachin, 2017).

In fact, some authors are quite sceptical concerning Blockchain. Levine (2018), although conceding Blockchain "certainly has some value", quotes research firm GlobalData's view that Blockchain is "awash with hype, but with a powerful core value proposition" and that its "bubble will burst in the next two years and will have lost much of its gloss by 2025". The reasoning for this view is based on three concerns: -

1. Distributed databases will always be slower than centralised ones.
2. Many technologists propose to use Blockchain for what can be done with existing technology.
3. Blockchain's real value is that it can be aligned to a "very narrowly scoped set of scenarios where it is impossible to agree on a central point of trust".

This paper's author, however, believes the truth is 'in the middle'. Levine's (2018) view is that of an old-world technologist not ready to explore the art of the possible with innovative technologies that are already proven disrupters. There is no denying from the above examples that Blockchain is a disrupting technology and its disruptive influence will continue to grow. The challenge for society is how to prepare for that disruption, both positive and negative.

Nonetheless, more regulation may be required. GDPR implications need to be considered for example. An element of GDPR is the 'right to be forgotten' (European Union, 2016). Blockchain is designed in such a way that nothing is erased or forgotten. Companies that could potentially be impacted, especially in the financial services area, are already developing their own private Blockchains. Will this pre-empt the potential positive disrupting benefits for society? Time will tell.

This completes the review of disruptive technologies generally and Blockchain specifically. The next chapter will look at what preparations should be considered by those entities that will be impacted.

## 2.4 The Way Forward

Brynjolfsson and McAfee's (2015) interview with the Harvard Business Review, three years after the publication of their eBook, Race Against the Machine, did not really show a change in their original optimistic position with regard to emerging disruptive technology. However, it did detail their growing concern for a lack of dynamism being shown by companies and governments in dealing effectively with the surge in emerging technologies and their societal impacts. They identify five courses of action that are required to address the disruption being caused by emerging technologies –

1. The school curriculum needs to change so that skills needed today and going forward are taught from primary school level. Such skills would include those that enhance creativity, entrepreneurship and problem solving, areas still not handled well by computers. The idea is not to look to compete against machines, but to work with them.
2. Heavy investment in infrastructure required for societies to be successful in a heavily technological world is needed now and should be considered an investment in the future.
3. The structures to enhance and support entrepreneurship need to be a focus for national governments. Brynjolfsson and McAfee (2015) are seeing a decline in new companies setting up and yet young fast-growing businesses are who provide most of the employment opportunities in the future.
4. Immigration, currently a hot-topic in many parts of the western world, is actually a requirement. Immigrants come with new ideas for business and are

generally a good source of jobs. They also assist those economies maintain a level of taxation required to support an aging population.

5. Governments worldwide need to increase their investment in research and development (R&D) activities to encourage companies to take part in such programs. Even in the US, Brynjolfsson and McAfee (2015) are seeing a decline in R&D spending as a percentage of Gross Domestic Product (GDP).

Brynjolfsson and McAfee's (2015) points are both relevant and timely. The changes suggested will not be easy to make and will take some courage, particularly from nations' policy makers.

Del Rosal (2015) reinforces the points made by Brynjolfsson and McAfee (2015) above. The areas he suggests as requiring societal focus are similar. Schools and colleges need to move away from an emphasis on memory-focused learning and focus on developing creative skills to enhance entrepreneurship. With the internet, everything you learn by rote traditionally in school is available at the 'touch of a button' today. There are some advances in this change today with Montessori schools but generally, society's approach to early education (primary and secondary school) has not changed.

A focus on problem solving is another area of opportunity raised by Del Rosal (2015). Following on from education is a move to developing a 'problem solving' frame of mind. This will lead to more entrepreneurship and a focus on the application of these new technologies to solve problems or fill gaps in society or industry.

It is clear from a review of the literature on technology disruption that the labour market will change drastically. With productivity increases happening because of automation and artificial intelligence and other innovations, job specialisation will become more the norm, meaning there will be fewer jobs to be had. However, a company needs consumers with disposable income to buy their products and services. Del Rosal (2015) believes governments are going to have to consider guaranteeing members of their society a basic income regardless of if they earn it or not, a concept that comes with controversy.

Whilst true for all emerging technologies, but focusing on preparing for the impact of Blockchain specifically, Collins (2017) begins by detailing four points questioning the hype surrounding Blockchain: -

1. It is important to "keep an eye on the widening gap between the claims being made about potential DLT applications". Similar to the point made by Cachin above, a level-headed review of what Blockchain can do is required.
2. The issue of a lack of trust is given as one of the big benefits of Blockchain, but is a lack of trust in big companies and government institutions a reality or a perception and do we really need a new technology to fix it? Again, careful consideration needs to be given to question if this is a case of a technology being applied to a "problem no one has".
3. Staying on trust, with Blockchain it must be recognised that it will be necessary to trust the entire environment from the underlying technology to the computer scientists developing the cryptography embedded in the various Blockchains.
4. Some thought needs to be given to the potential unintended consequences of replacing "socially grounded methods of generating trust with technologically distributed methods".

Iansiti and Lakhani (2017), in their article 'The Truth about Blockchain', take a less sceptical, yet more measured view of Blockchain's potential to have a disruptive impact. To begin with, they believe that potential is real and likely to occur. However, they also believe a lot of work is required to build the required infrastructure to allow that impact to fully manifest. They see Blockchain as more than just a disruptive technology, but a '*foundational*' one, and one that will go through four phases of development before reaching its full potential.

To provide context, Iansiti and Lakhani liken the advent of Blockchain to that of TCP/IP, the technology that allowed the internet to become the shared public network, "without any central authority or party responsible for its maintenance". TCP/IP began life with a "single-use case", email between researchers in the US Department of Defence working on ARPAnet, the precursor to the commercial internet in existence today.

Next, came the “localisation” stage, where several large technology companies such as Sun, Hewlett-Packard and Silicon Graphics developed localised private networks within their own organisations, building applications and tools beyond simple email and improving their internal productivity beyond anything they previously achieved.

Once critical mass was reached in terms of usage and infrastructure, the next stage, “Substitution”, came into effect. This is where companies such as Amazon (online bookstore), Expedia (online airline ticket purchasing) or CNET (online news) were born, substituting existing traditional companies or industries. Using the now established TCP/IP infrastructure, these new companies took advantage of the great customer-reach of the internet to build their respective businesses.

Finally, stage four, referred to as the “Transformative” stage, saw new companies developing innovative ways of doing business. For example, ebay, Napster or Google; each have transformed their respective industries through transformative disruption.

Iansiti and Lakhani’s (2017) point is that, just as it was with TCP/IP, the movement of Blockchain through the above stages will take time as there are more stakeholders involved at each step. This means infrastructure needs to be built, agreed standards need to be set and accepted by all parties, and multi-user use cases need to be validated and implemented for Blockchain to finally become ubiquitous.

The majority of authors agree that Blockchain technology has great potential. The examples above demonstrate this, especially for society. However, it is also clear that further research is required to bottom out the potential pitfalls to prepare society for it. As is generally true for most emerging technologies, the research informs us that, society is not aware of Blockchain or its potential disruptive impact. That does not mean those governing societies can turn a blind eye though. There is much work to be done.

This completes the Literature Review section of this research paper. The review covered disruption caused by emerging technologies generally, providing some examples of how this manifests. It then moved onto Blockchain to demonstrate the disruption that can be caused by just one of the emerging technologies.

The next chapter lays out the Research Question of this paper, before moving on to discussing the research methodology used.

## Chapter 3: Research Question

As stated in the introduction, this thesis paper has three objectives –

1. Review the available literature to gain an understanding of Disruptive Technology generally and Blockchain specifically. Then, from this review, determine what potential disruptive impacts on society can be expected, both positive and negative.
2. Using the findings from the review, and the results of a quantitative web survey conducted on the topic for this Thesis, to determine if society is aware of the forthcoming innovations and is prepared for the potential disruption they will bring.
3. Collate recommendations from the review and the web survey on possible courses of action open to companies, governments and societies to prepare for the inevitable technological disruption.

These objectives translate into the three research questions –

1. **What are disruptive technologies generally, and Blockchain specifically, and how do they impact society?**

   The literature review identified what are considered to be the next emerging, innovative technologies and presented some examples of what their potential societal impact might be. This was further examined using the specific example of Blockchain. Analysis of the results of the quantitative web survey discussed in the next section will further assess this question.

2. **Is society aware of the various emerging technologies and is it prepared for their disruptive effects?**

   When a new technology arrives and is put to a disruptive commercial use, other companies in that industry are often caught unprepared and suffer consequently. Is the same to be said for society in general? Disrupting an industry also disrupts those parts of society associated with that industry. Are we aware of what is coming and are we prepared?

3. **What must society do to prepare?**

Suspecting the answer is society is aware, but not fully prepared for all the disruptive implications, what needs to be done?

To answer these questions, it is the intent of this author to use the findings from the literature review and the results of the quantitative web survey analysis to present a view confirming or denying society is fully prepared for the forthcoming disruptive technology tsunami and what it needs to do to prepare if not.

# Chapter 4: Methodology

## 4.1 Introduction & Proposed Methodology

Working from the research objectives and questions as articulated above, the approach in terms of research methodology is to follow the guidance of the 'Research Onion' (Saunders et al, 2012) as described in the figure below.

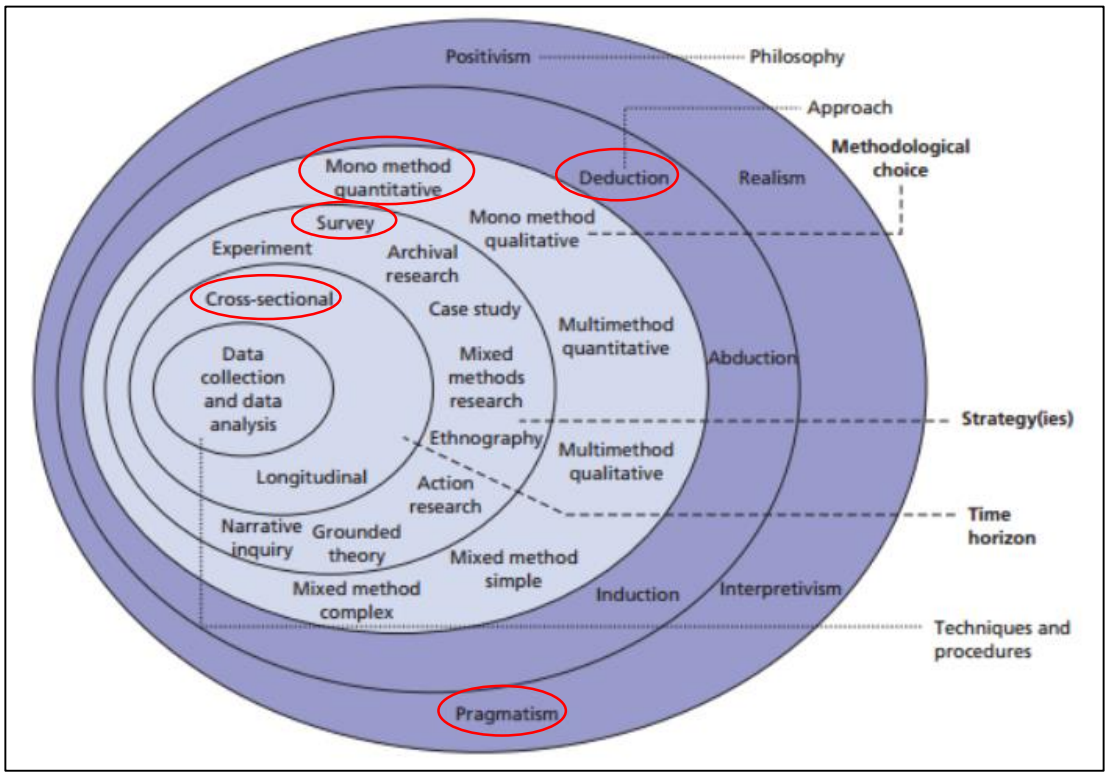


Figure 4 – The Research Onion
*Source: Saunders, Lewis and Thornhill 2011: p128*

The red circles within the above figure show the path taken 'through the research onion' with this research paper, from ontological objectivism through to epistemological positivism and onwards through the layers as shown.

## 4.2 Research Philosophy

Saunders et al (2012) hold the view that practical considerations will influence one's chosen research methodology. That is certainly the case with this research paper. Attempting to determine the potential impact of generally unknown, or at least not very well known, technologies informed the approach taken here.

However, Saunders et al (2012) state that whilst this is true, researchers are more likely influenced by their personal "view of acceptable knowledge and the process by which it is developed".

Bryman's (2012) view of ontology is that it is "concerned with the nature of social entities". In other words, the question is if social entities are objective ones that have a "reality external to social actors" or are they creations developed by "perceptions and actions of social actors". There are two ontological sides to the ontology continuum, objectivism and subjectivism. The one chosen by this author is influenced as Saunders et al describe above (Saunders et al, 2012).

Objectivism, according to Bryman (2012), is defined as "social phenomena and their meanings have an existence that is independent of social actors". While subjectivism is defined as, "social phenomena and their meanings are continually being accomplished by social actors". For this research paper, an objectivist view is taken. This author does not necessarily hold the view that one or the other end of the ontology spectrum is dependent on the leaning of the person or persons conducting the research, but that the context of the situation has more of an influence than suggested by Saunders et al (Saunders et al, 2012).

The second level of research philosophy is epistemology, the "rules of the game of knowledge generation". (Pearce, 2013). It asks the "question of whether the social world can and should be studied according to the same principles, procedures and ethos as the natural sciences?" (Bryman, 2008). Like ontology, there are two sides to the epistemology continuum, positivism and Interpretivism.

Bryman (2008) states that positivism is the belief that social phenomena and knowledge can only be measured using the scientific method. That is, through observation by the senses. Methods utilised by objectivists would include surveys, structured interviews and experiments. Interpretivism, on the other hand, does not believe the scientific method is a valid approach. Rather, study of the social world and its actors requires understanding the subjective interpretation of social interactions. This can be achieved through developing a rapport and empathy with the subject(s) of one's study.

However, Saunders et al (2012) refer to another point on the epistemology continuum referred to as pragmatism. As described by Kelemen and Rumens (2008), pragmatists are of the view that "concepts are only relevant in as much as they are relevant for action". In other words, pragmatists do not hold the view that a researcher's philosophy does not have to be one of either a positivist or an interpretivist position but that the research objective(s) will drive the research method chosen.

For this research paper, similar to the ontological view, this author is taking a pragmatist approach, as it is most suited for the subject matter being researched. This author was originally going to take an interpretivist / inductive approach to this research, using semi-structured interviews of subject-matter experts, but changed to a pragmatist / deductive approach and a cross-sectional web survey. This decision was taken based on the research objectives listed above and the time constraints imposed on the research project. This is clear evidence of this author's pragmatist research philosophy that the objectives and context drive the research methodology.

## 4.3 Research Approach

The next layer of the research onion is the research approach to be taken; is it an inductive approach or a deductive one?

Saunders et al, (2012) tell us deductive reasoning is where a set of research premises are formed from which a conclusion is logically derived. The conclusion arrived at is true when all the premises are true. For example, assume the following premises –

- Tiger Woods, the world-famous golfer, only wears a red polo shirt on the final day of a competition.
- Tiger has made the cut and today is the final day of the competition.

The conclusion therefore is that Tiger will be wearing a red polo shirt playing today. The premises are true therefore the conclusion has to be true.

Inductive reasoning, on the other hand, is where the conclusion does not necessarily follow from the premises, even if supported by them. For example, the premises here are –

- An old group of friends go for a few beers every Thursday night.
- Tonight is Thursday.

Therefore, the conclusion is the group of friends are going for a beer. In this case, there is a high probability the conclusion is true, but it is not guaranteed. Perhaps it is summer and one or more is on a family vacation.

For this research paper, deductive reasoning is used as it is deemed most suitable. Using evidence gathered from the literature review and web survey, the author forms premises regarding disruptive technology generally, and Blockchain specifically, to prove the conclusion that society is aware of new emerging technology and the fact it may impact their lives, but is under-prepared for the disruption it will bring.

## 4.4 Methodological Choice

The methodological choice for this research paper is quite straightforward; it is mono-method quantitative, using a web survey questionnaire to supplement and validate the findings from the literature review.

Saunders et al (2012) detail the options open to a researcher in terms of the choice of research methodology in a decision tree format that creates a continuum running from simple to complex. The 'simple' path involves a mono-method quantitative or qualitative study. The complex path involves a multi-method approach, where a researcher might use more than one qualitative or quantitative instrument, or mixed method approach, where a researcher might use a mixture of qualitative and quantitative instruments.

## 4.5 Research Strategy

The fourth layer of the research onion (Saunders et al, 2012) looks at the strategy employed by the researcher. There are several options, both quantitative and qualitative to choose from but clearly, the researcher's choice is influenced by their respective ontological and epistemological leanings as well as the research approach decided upon.

For this research paper, the author has chosen a quantitative web survey. The research questions outlined in the research question section are as follows –

1. What are disruptive technologies generally, and Blockchain specifically, and how do they impact society?
2. Is society aware of the various emerging technologies and is it prepared for their disruptive effects?
3. What must society do to prepare?

It is this author's opinion that a web survey will allow the collection of data from a reasonably sized cross-sectional sample of society. Saunders et al (2012) are of the view that using a survey strategy allows the researcher to collect quantitative data, which can be statistically analysed and the survey data can be used to discover and understand "particular relationships between variables and to produce models of these relationships". It is this author's intention to do just that.

The approach taken with the web survey is to utilise a number of different social and professional channels to reach out to an appropriately sized cross-section of society. Using Google forms to create the web survey, the channels used included –

- Social media – LinkedIn and Facebook.
- Colleagues – NCI classmates and DEPFA Bank plc IT employees.
- Technical – Several Fujitsu Information Technology (IT) contacts.

The web survey, which can be viewed in Appendix A, is completely anonymous to encourage a high response rate. Intentionally, it has a narrowing focus in line with the research's move from technology disruption generally to a specific focus on Blockchain. It begins with a series of baseline questions about the respondents themselves, including age, gender and education level attained.

The web survey then moves into a set of disruptive technologies questions to get a feel for the responder's awareness of those technologies, how they feel about them and if they have any concerns regarding them. Next, the web survey moves onto Blockchain, initially getting a feel for responder awareness, leanings and concerns. Then, specific examples of Blockchain's potential are provided to garner responder thoughts on them, finishing off with a question on trust of the Blockchain technology.

Sixty-seven responses to the web survey were received, with the response analysis reported in the findings and analysis chapter.

## 4.6 Time Horizons

The final layer of the research onion is the time horizon, with the possible options being a cross-sectional study or a longitudinal one. Saunders et al (2012) recognise that most research studies will be cross-sectional due mostly to the time constraints associated with such undertakings. A cross-sectional study is a "snap-shot taken at a particular time", while a longitudinal study is one that takes place over a period of time. (Saunders et al).

With the aforementioned web survey, it is clear this author is using the cross-sectional option. This decision is due to the time-bound nature of the Thesis module of the Masters of Business Administration (MBA) course. In addition, the subject matter and the research questions are best addressed through use of a cross-sectional survey. A possibility for future research might be to turn this study into a longitudinal one. It could be repeated every two or three years to see if the expected technology disruption occurred and how society dealt with it.

## 4.7 Ethical Consideration

Panter and Sterba (2011), in the publication 'Handbook of Ethics in Quantitative Methodology', present a view that whilst colleges ensure research ethics is covered as a topic for students undertaking research, quantitative topics are often overlooked. This is somewhat understandable, as quantitative methods tend to be objective and hands-off in their approach.

However, ethics clearly should never be ignored when researching a topic requiring input from people. When approaching the challenge of collecting data for this research study, this author considered the ethical aspect of the web survey when designing it. Consequently, recognising that the web survey would require a small number of baseline questions such as age, gender and education level, the decision was taken to make it completely anonymous.

The baseline section of the web survey contained the following declaration… "Your responses will remain anonymous, only to be used as part of a National College of

Ireland MBA Dissertation on the titled topic." Not even the email addresses of the respondents were collected, thereby putting at rest any concerns respondents may have had.

## 4.8 Limitations

The main limitation of this research was time constraints. There is abundant research in existence on technology disruption and Blockchain is starting to be recognised as a significant innovation, one that will have far-reaching impacts. However, this research paper submission is part of a fixed-term MBA class. There are at best five to six months to complete the Thesis module, four of which have other modules running in parallel, thereby reducing the amount of time available to complete the study. In addition, time is further impacted as the MBA course is a part-time one, meaning one must continue to meet one's work obligations whilst attending to their thesis.

The second limitation is the subject matter itself and how aware people are of it. The web survey was viewed by close to 1,000 people, yet only 67 responded. One can speculate a lack of interest in the subject matter, or a lack of understanding of it, or even an unwillingness to respond due to the small amount of personal data being requested, all contributed to this poor response rate. It being a completely anonymous web survey makes it hard to be certain.

Thirdly, this author's knowledge of SPSS, the IBM statistics package required to analyse quantitative survey data, is limited and based self-instruction via YouTube. Consequently, the findings and analysis chapter might not be as detailed as is required.

Finally, there is an assignment limit set by the college of 20,000 words per thesis, which precludes the author from examining all twelve disruptive technologies shown in Figure 1 in the Introduction.

This completes the Methodology chapter of this research paper. Using Saunders et al's (2012) research onion, the author takes the reader through each 'layer' of the methodology approach, providing both background and context for the approach

utilised. The next chapter, findings and analysis, reviews the web survey findings to understand if the research objectives were achieved and the questions answered.

# Chapter 5: Findings and Analysis

## Introduction

As stated in the introduction and in Chapter 3, the three main objectives of this thesis paper are –

1. Review the available literature to gain an understanding of disruptive technology generally and Blockchain specifically. Then, from this review, determine what potential disruptive impacts on society can be expected, both positive and negative.
2. Using the findings from the review, and the results of a quantitative web survey conducted on the topic of this thesis, to determine if society is aware of the forthcoming innovations and is prepared for the potential disruption they will bring.
3. Collate recommendations from the review and the web survey on possible courses of action open to companies, governments and societies to prepare for the inevitable technological disruption.

These objectives translate into the three research questions –

1. What are disruptive technologies generally, and Blockchain specifically, and how do they impact society?
2. Is society aware of the various emerging technologies and is it prepared for their disruptive effects?
3. What must society do to prepare?

The approach taken in this chapter is to analyse the results of the quantitative web survey and report on findings pertaining to addressing objective two and answering question two. The chapter will provide details of the web survey itself along with an analysis of the results. The chapter will include views on how the web survey findings link to the points raised in the literature review.

## The Quantitative Web Survey

Section 4.3 above, research strategy, provides detail regarding how the web survey (attached in Appendix A) was conducted and why. The author intentionally chose to use the social media channels LinkedIn and Facebook and various personal and

professional contacts to conduct the web survey. A request was also made of respondents to pass the web survey on to their contacts to further increase its dispersion.

The web survey is broken up into four distinct sections –

- Baseline – Questions involving queries of age, gender and education level achieved.
- Disruptive Technology – General questions regarding respondents' knowledge and awareness of emerging technology innovations and any concerns they may have concerning them.
- Blockchain General – Introductory questions on Blockchain to establish if there is an awareness of Blockchain among respondents.
- Blockchain Specific – Using specific examples of how Blockchain might be used, determine how respondents viewed the technology and if their view of it was more positive or negative.

The web survey was completely anonymous. It did not collect any email addresses or other contact detail of any respondent even if this author personally knew some of them.

There were over one thousand views of the proposal, yet only sixty-seven hard responses. This low response rate might be worth researching itself, but appears to be backed up with low response rates to surveys generally. Manfreda et al (2008) provide support from various researchers in their paper 'Web surveys versus other survey modes' that, as with traditional surveys, there is an issue of non-response with web surveys generally. The supposition is the practices of direct marketers and other over-surveying activities has had an adverse effect on response rates through what might be referred to as survey fatigue.

As an example, Figure 5 below shows there were 970 views of the web survey on the LinkedIn website. (There were a further 40 views in a reminder post on the same site). Added to this, the distribution to personal and professional contacts directly and through Facebook backs up the 1000+ views.

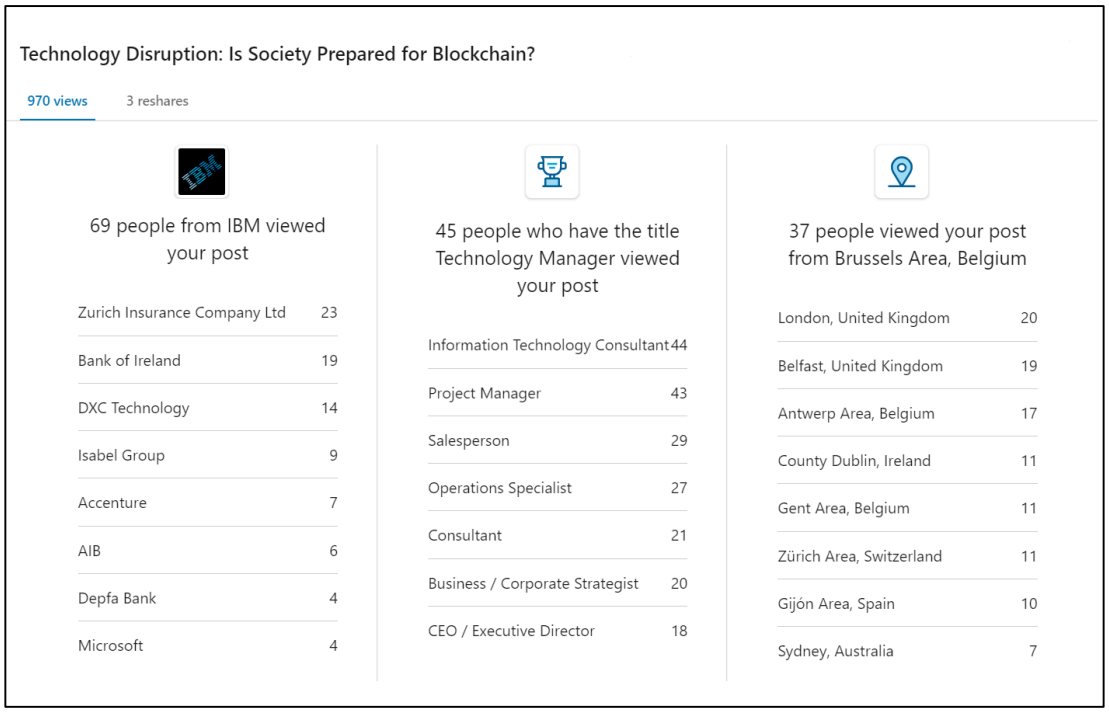


Figure 5 – Web Survey Viewing Feedback
*Source: Author's LinkedIn.com home page*

What is interesting from Figure 5 above is the dispersion of the views on LinkedIn. There is a decent spread across companies, professionals at various levels and geography. As the web survey is anonymous, no direct correlation can be made as to whether the spread above was sustained through to the types and location of respondents. However, the opportunity for that correlation to exist is worth investigating, although outside of the scope of this research. What the spread above does demonstrate though is confirmation that there is an interest in the subject matter. For instance, it is well known within the IT community, (to which this author belongs), that IBM are heavily invested in developing Blockchain applications. As an example, the literature review discusses the efforts of IBM and Walmart to develop a Blockchain to track the source of the foodstuffs Walmart sell (Hackett, 2017).

## Baseline Questions Feedback

There are three baseline questions asked on the web survey. Age range, gender and education level attained. Of the 67 respondents, the breakdown along these three aspects is as follows -

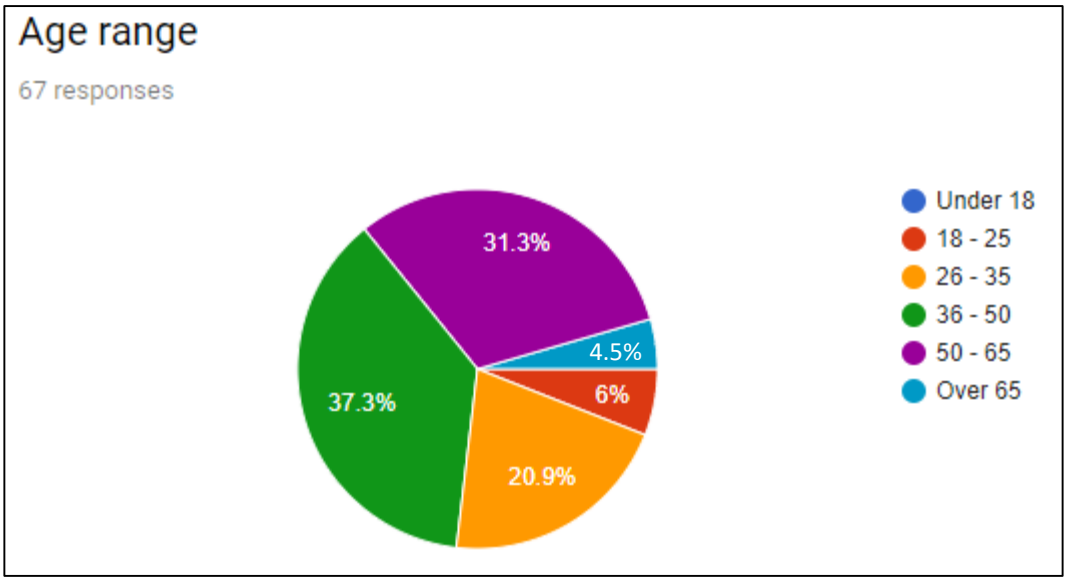


Figure 6 – Web Survey Response to Age Range
*Source: Google forms Thesis web survey*

There is a decent spread of ages between 26 and 65, with a small handful outside this range. There were no respondents under the age of 18, potentially a failing of how the survey was targeted. Most respondents came from the 35 to 50 years grouping.

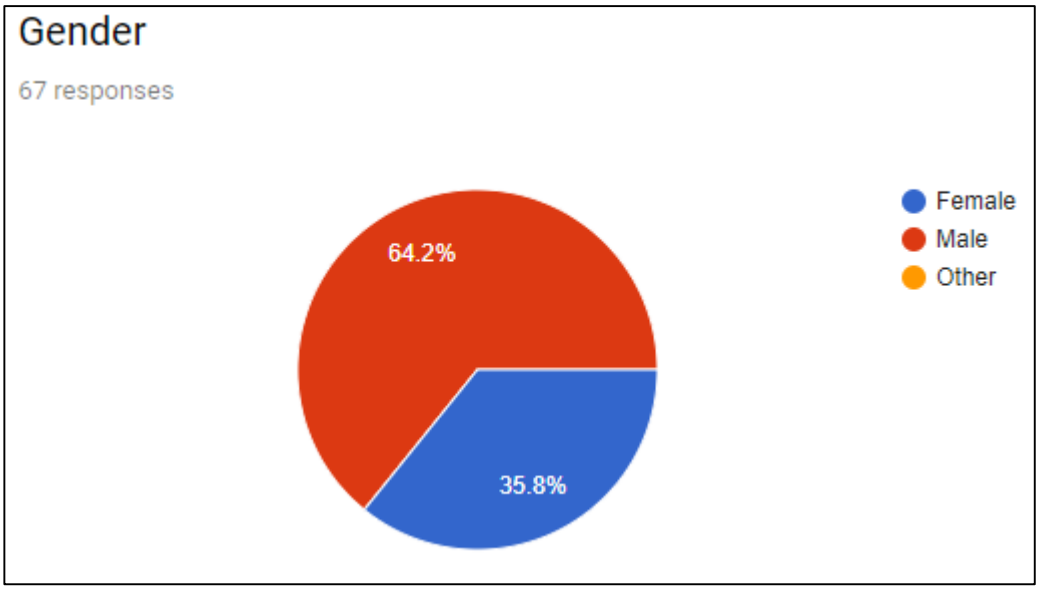


Figure 7 – Web Survey Response to Gender
*Source: Google forms Thesis web survey*

Clearly, a majority of respondents were male, even though the mix of those targeted would be closer to evenly split across genders.

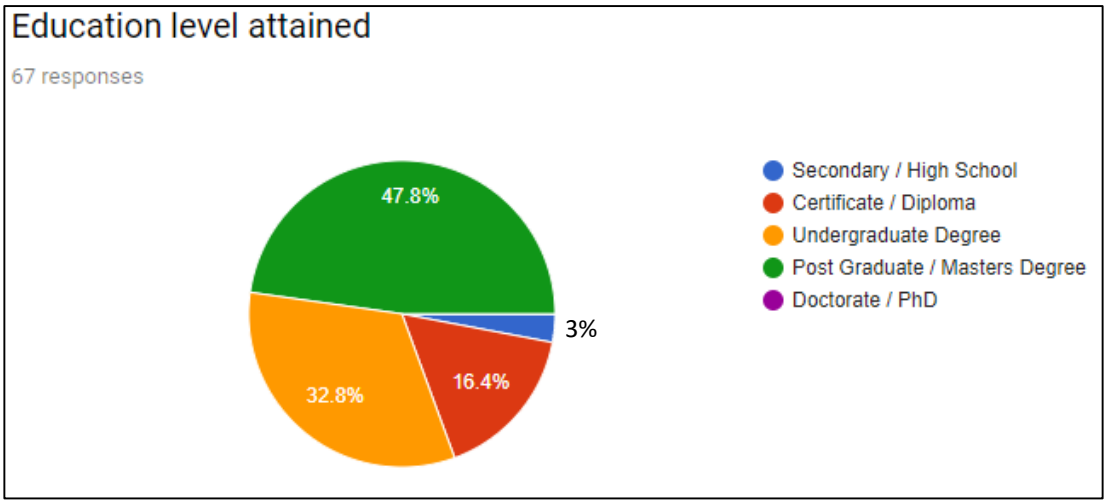


Figure 8 – Web Survey Response to Education Level Attained
*Source: Google forms Thesis web survey*

The level of education attained by respondents was primarily post-secondary, which aligns with the author's social and professional circles, but not entirely. More reflective perhaps of the fact only a small percentage of the population stops at Leaving Certificate or equivalent, but this would need academic support outside the scope of this paper.

### Disruptive Technology Questions

The next part of the web survey looks at how familiar the concept of Technology Disruption is and how respondents understand it. That is, do the respondents welcome it? What impact might it have? What of the various impacts would concern the respondent? Finally, if the respondent perceives any benefit to society. The responses to these points are details in the next six figures.

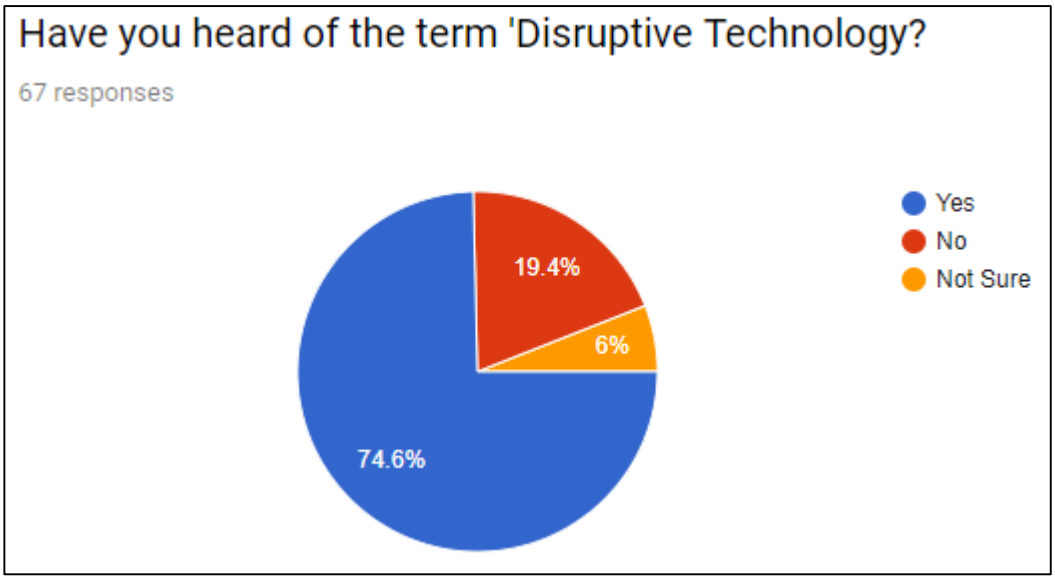


Figure 9 – Awareness of the Term Disruptive Technology
*Source: Google forms Thesis web survey*

Almost three-quarters of respondents heard of the term, 'disruptive technology', which bodes well for the understanding of changes wrought by innovative technologies, if not perhaps the outright understanding of potential impacts. To determine if there is a correlation between age, gender, education level attained and being aware of the term Disruptive technology, the IBM statistics application SPSS is used, with results shown in Figure 10 below.

| | | Age Range | Gender | Education level attained | Have you heard of the term 'Disruptive Technology? |
|---|---|---|---|---|---|
| Age range | Pearson Correlation | 1 | -.090 | -.097 | -.229 |
| | Sig. (2-tailed) | | .470 | .433 | .063 |
| | N | 67 | 67 | 67 | 67 |
| Gender | Pearson Correlation | -.090 | 1 | -.153 | .133 |
| | Sig. (2-tailed) | .470 | | .218 | .282 |
| | N | 67 | 67 | 67 | 67 |
| Education level attained | Pearson Correlation | -.097 | -.153 | 1 | -.288 |
| | Sig. (2-tailed) | .433 | .218 | | .018 |
| | N | 67 | 67 | 67 | 67 |
| Have you heard of the term 'Disruptive Technology? | Pearson Correlation | -.229 | .133 | -.288 | 1 |
| | Sig. (2-tailed) | .063 | .282 | .018 | |
| | N | 67 | 67 | 67 | 67 |

Figure 10 – Correlation of Aware of Technology Disruption to Age, Gender and Educational Level Attained
*Source: Source: Google forms Thesis web survey & SPSS*

The measure used to confirm correlation is known as Pearson's Correlation and it uses a scale from -1 to +1. Perfect positive correlation exists if the number reported is 1 and perfect negative correlation if the score is -1. The closer to +1 the score is, the more likely there is a correlation between the variables being measured.

As the scores, highlighted in yellow above, are closer to zero in the figure above, it can be surmised there is no correlation between the variables, which again bodes well for awareness of forthcoming disruption; there appears to be a general awareness.

The next question in the web survey investigates how aware are respondents regarding the specific disruptive technologies. Figure 11 shows the results (Note – the bottom 4 were added in as additional disruptive technologies by an individual responder; focus is on top 10).

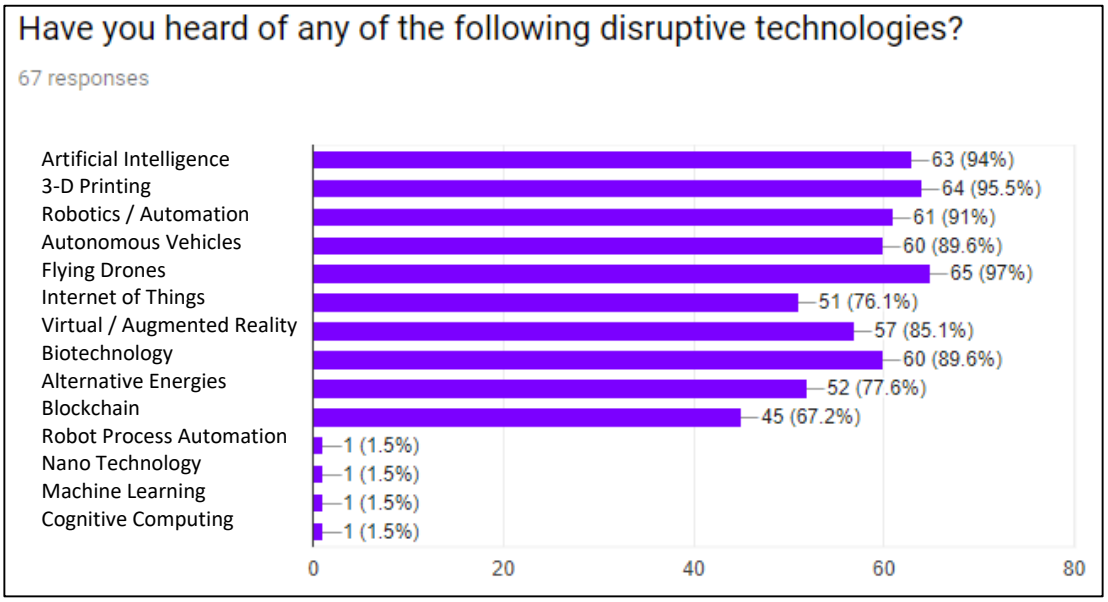


Figure 11 – Awareness of Specific Disruptive Technologies
*Source: Source: Google forms Thesis web survey & SPSS*

It is clear from the figure above that people generally are familiar with the disruptive technology terms and this would most likely be because many of them, such as drones, autonomous cars and 3-D Printing are already in evidence in society. Interestingly, Blockchain recorded the lowest awareness at 67.2% of respondents, which is still reasonably good. This does not mean people are fully aware of the potential impact however.

Staying with disruptive technology, respondents were then asked if they welcome such innovations and how disruptive they believe them to be. The responses are shown in Figure 12 below.

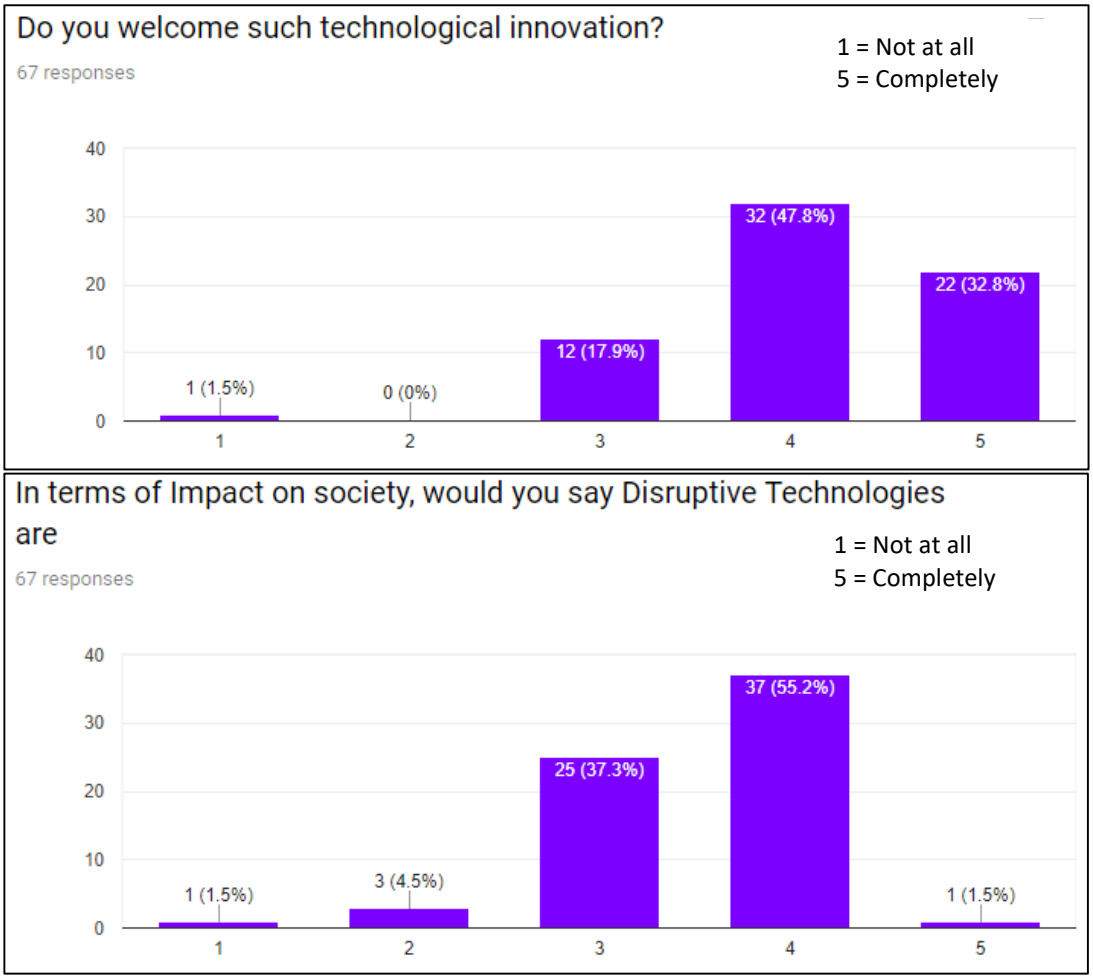


Figure 12 – General View of Disruptive Technologies
*Source: Source: Google forms Thesis web survey*

As was seen in the Literature review, Brynjolfsson and McAfee (2015) remain optimistic that society will deal with the disruption emerging technology throws at it, even if more preparation is required. This is borne out by the graphs in Figure 12 above. Most respondents welcome technology innovation (80.6% scoring 4 or 5) and believe the impact on society will be positive (56.7% scoring 4 or 5). There is a however, a noticeable drop between the number of 'welcoming' respondents and the number of 'positive impact' respondents. This would suggest a similar view to Brynjolfsson and McAfee (2015).

Using SPSS to determine if the views in figure 12 above are influenced by gender or educational level attained, the following is identified –

| | Welcome Tech. Innovation | Impact on Society |
|---|---|---|
| **Male** | 4.21 | 3.60 |
| **Female** | 3.60 | 3.33 |

| | Welcome Tech. Innovation | Impact on Society |
|---|---|---|
| **Secondary / High School** | 3.00 | 2.50 |
| **Certificate / Diploma** | 3.91 | 3.09 |
| **Undergraduate Degree** | 3.86 | 3.45 |
| **Post Grad / Masters** | 4.41 | 3.75 |

Further research is required to understand the implications of these scores. On the gender aspect, does the higher average participation of males in science, technology, engineering and mathematics (STEM) subjects influence the scores? (Athena Analytics, 2018).

There is an apparent correlation between the education level of the respondent and the higher average score on both questions in figure 12; the higher the education level attained, the more welcoming to innovative technologies the respondent is, but also the more aware the respondent is of the potential impact on society. This can be linked to the finding in the literature review that talent will become more important than labour in society, with the higher skills roles become more valuable. (Schwab, 2017). Seeking a higher level of education demonstrates a recognition of a requirement to prepare oneself for the composition of the technology-driven labour market in the future.

Digging a little deeper on the topic of emerging disruptive technologies, respondents were asked what kinds of societal impact would concern them and do they foresee any benefits from disruptive technology innovation. The intent behind these questions is to see if the sample of society chosen for the survey understand what disruptions might manifest and then if they still remain optimistic. The results are shown in Figures 13 and 14 respectively.

Figure 13 shows that people are mainly concerned with loss of jobs, increased wealth inequality, increased surveillance by the authorities and, to a lesser extent, human control of artificial intelligence. This aligns with the view of Klaus Schwab (2017), who views the loss of jobs and a greater financial inequality gap as major causes of social unrest. It also supports Schafer's (2018) view that parts of humanity are becoming "dislocated not only technologically but also in economic and social terms". The web survey respondents would appear to concur.

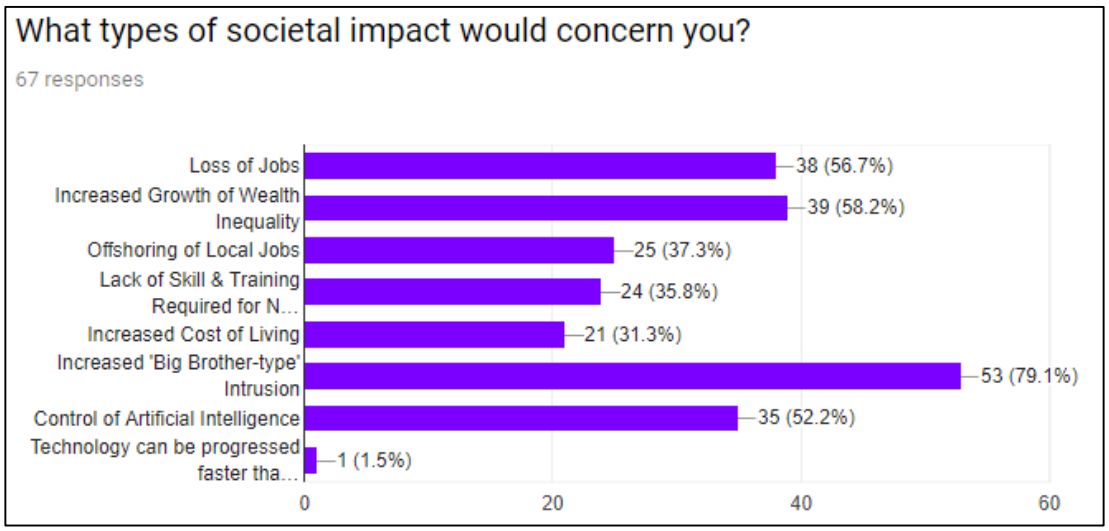


Figure 13 – View of Disruptive Technologies Societal Impact
*Source: Source: Google forms Thesis web survey*

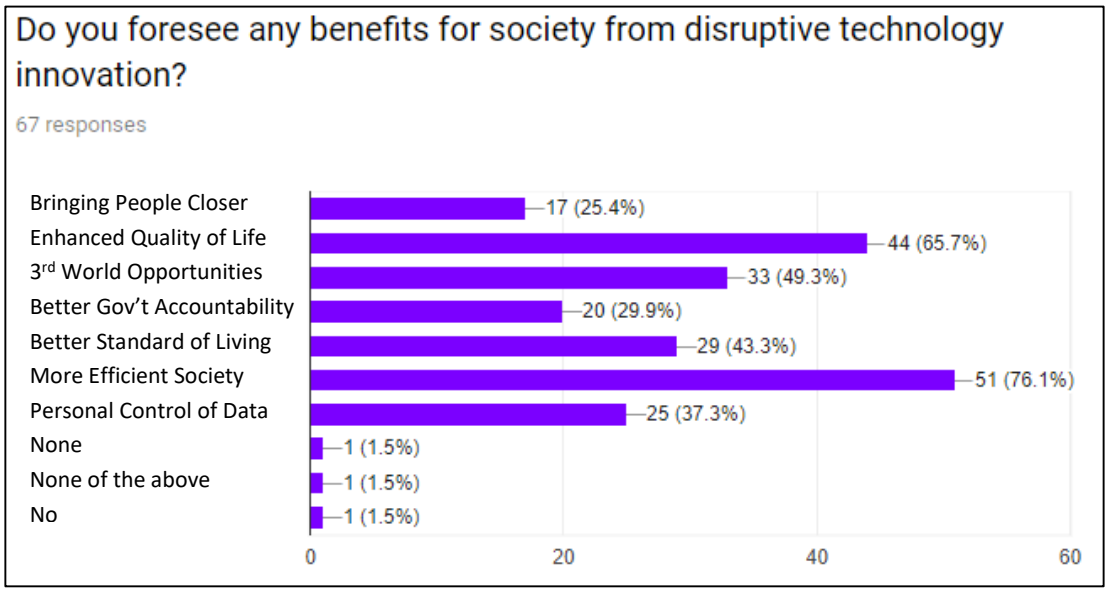


Figure 14 – View of Disruptive Technologies Benefits
*Source: Source: Google forms Thesis web survey*

Nevertheless, the optimism remains. Figure 14 demonstrates that, even though there are concerns regarding societal impact from emerging technologies, there is also a view from the respondents that there will also be societal benefits. The benefit options were listed based on what was found in the literature review, but intentionally not listed verbatim. For example, making life more efficient would include the developments covered in the IOT discussion. The author wanted respondents to put their own understanding on disruptive technology's benefits.

Interestingly, 'enhanced quality of life' and 'more efficient society' scored highest amongst responders, but 'bringing people closer' and 'more government accountability' are perceived as a benefit by less than a third of respondents in each instance. When comparing figures 13 and 14, it would seem there are both concerns and perceived benefits, but the concerns weigh heavier on the minds of the respondents than the perceived benefits. This however, does align with the findings from the Literature Review, for example, Davis and Philbeck (2017), who identified the twelve most pertinent disrupting technologies, their benefits and concerns.

### General Blockchain Questions

After providing a brief overview of Blockchain, respondents were asked if they were familiar with it. Figure 15 shows the response.

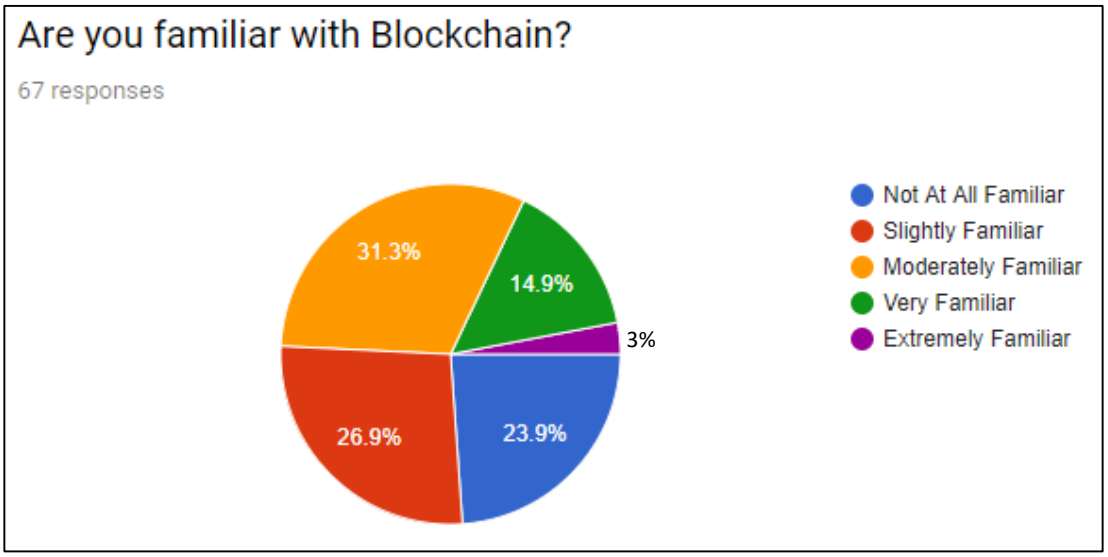


Figure 15 – Familiarity with Blockchain
*Source: Source: Google forms Thesis web survey*

The 'Not at all' and Slightly Familiar' categories account for 50.8%, which is significant considering this technology has been around since 2008 and has significant disrupting potential as was seen in the literature review. As can be seen above in Figure 11, Blockchain is the least well known of the emerging technologies.

When asked in what context each respondent had heard of Blockchain, cryptocurrencies accounted for over 76%, which is hardly surprising considering how popular Bitcoin has become in the last couple of years. Figure 16 confirms this.

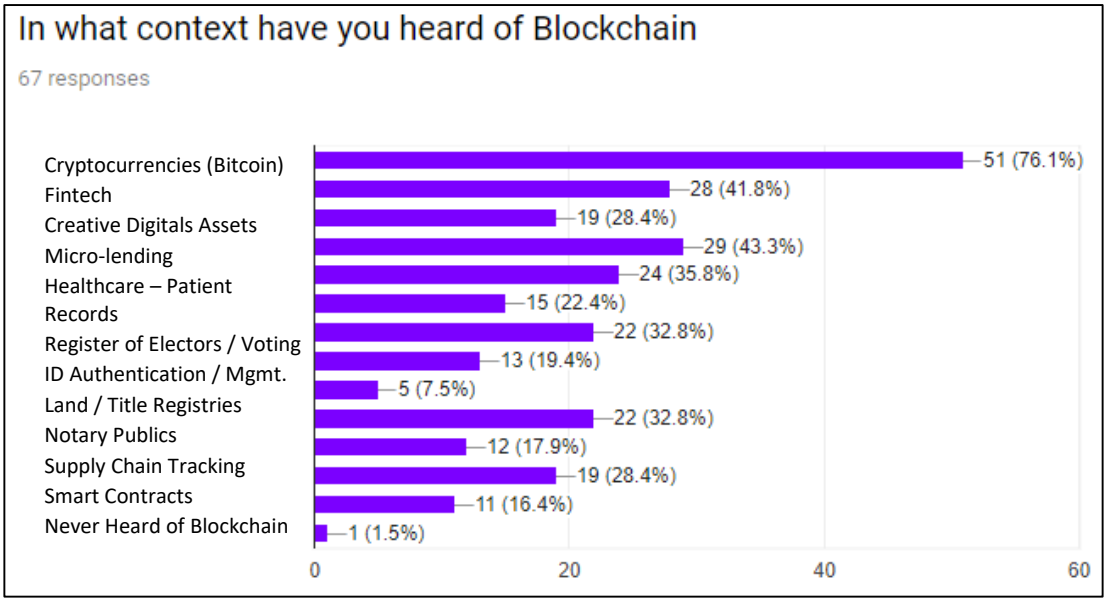


Figure 16 – Familiarity with Blockchain
*Source: Source: Google forms Thesis web survey*

This also demonstrates that the cryptocurrency concept is fairly well known even if the underlying technology of Blockchain is not. Once the 'Fintech' and 'Micro-lending' categories are removed, respondent familiarity drops off noticeably. Clearly, although unsurprisingly, there is a lack of pertinent knowledge of Blockchain beyond the financial services industry. This will be further examined when discussing respondent feedback regarding specific uses of Blockchain.

Further evidence of a lack of familiarity of Blockchain is shown in the next two general Blockchain questions asked. That is, which industries do respondents think will see disruption as a result of Blockchain and what barriers might there be to the introduction of the Blockchain technology. The results are shown in figures 17 and 18 below. In terms of disruption, and in line with 76.1% of respondents associating

Blockchain with cryptocurrencies, it is not surprising that the financial services industry is seen as the one most susceptible to disruption. This aligns with the literature review findings of Nowiński and Kozma (2017) that Blockchain's first incarnation was the underlying technology of the first cryptocurrency, Bitcoin. There is also alignment with Swan's (2015) view that Blockchain is going through generational expansion from Blockchain 1.0, which focuses on the cryptocurrencies, to 2.0 to include smart contracts and then to 3.0, which covers applications beyond the financial services Industry. The point is it is well understood by now that cryptocurrencies and the financial services industries are reasonably fresh in the minds of the responders.

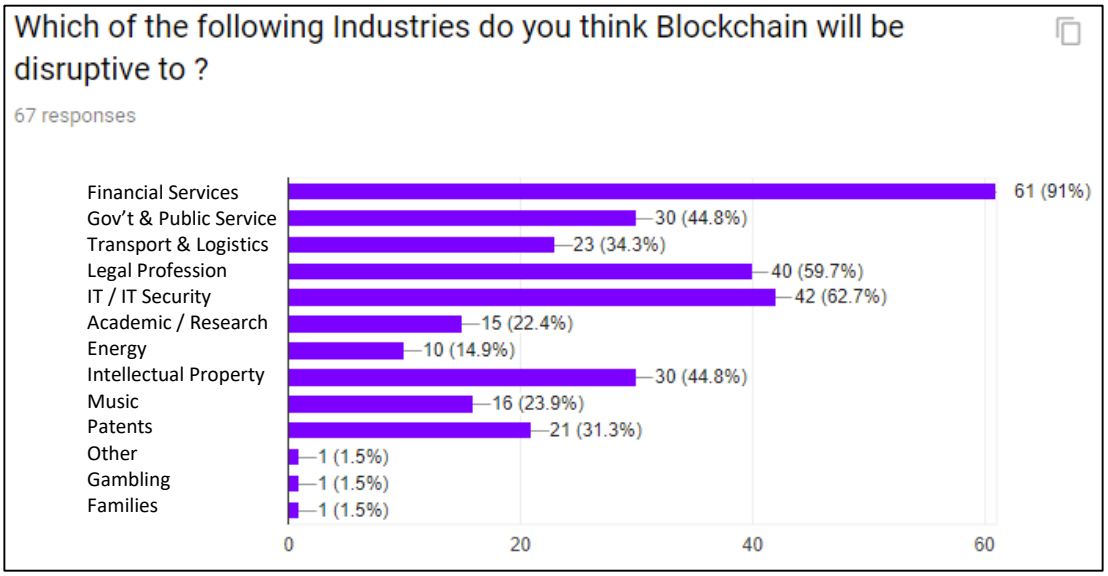


Figure 17 – Perceived Disruption from Blockchain
*Source: Source: Google forms Thesis web survey*

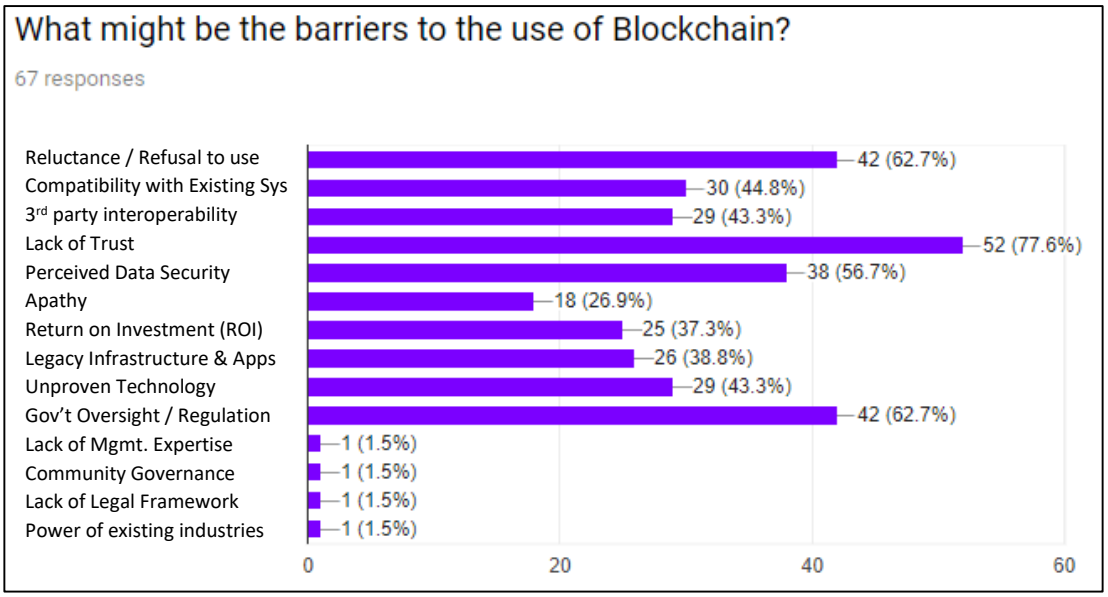


Figure 18 – Perceived Barriers to Entry for Blockchain
*Source: Source: Google forms Thesis web survey*

## Review of Specific Blockchain Applications

The final part of the survey narrows in on specific Blockchain uses to get a view from respondents on their awareness of Blockchain's potential and if it would be welcomed. Six specific examples are given, as outlined in Figure 19, asking respondents to give their view as to whether Blockchain is a positive or negative benefit to the industry referenced in each question. A score of one is wholly negative and five is wholly positive.

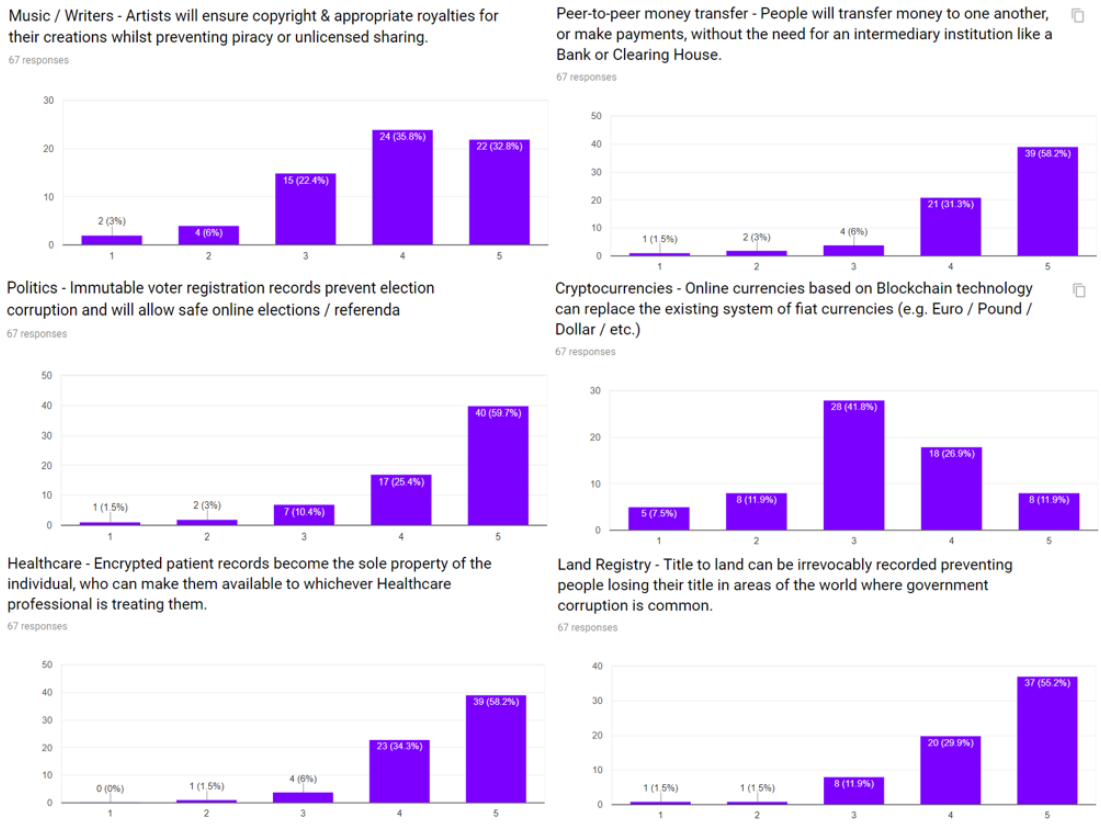


Figure 19 – Views of Specific Blockchain Applications
*Source: Source: Google forms Thesis web survey*

With the exception of the cryptocurrencies question, the majority of respondents welcome all Blockchain scenarios, even if there is a slightly cooler welcome for control of music and other creative copyrights. It is unsurprising that the feeling towards cryptocurrencies replacing fiat currencies is more balanced as in the explanation of Blockchain in the survey, one of the benefits outlined was "allowing transactional interaction directly between parties without going through intermediaries such as banks, aggregating companies or government institutions". The implications are a potential lack of regulation is a concern, which is one of the recommendations coming out of the research conducted by Brynjolfsson and McAfee's (2015)… that governments need to invest more in understanding the potential disruptive effects of Blockchain and other emerging technologies and prepare their citizens and societies for them.

Using SPSS to confirm this view, average response on each of the questions in figure 19 is as follows –

| | Music / Creative Arts | P2P Money Transfer | Politics | Cryptocurrencies | Healthcare | Land Registry |
|---|---|---|---|---|---|---|
| **Mean** | 3.90 | 4.42 | 4.39 | 3.24 | 4.49 | 4.36 |
| **Std. Deviation** | 1.032 | 0.855 | 0.904 | 1.060 | 0.683 | 0.865 |

Cryptocurrencies and the creative arts were the only two categories to have a mean, or average, below 4.00 and a standard deviation greater than 1.00, with healthcare having the highest mean and lowest standard deviation. This may be indicative of how challenging managing a nation's healthcare has become in the last couple of decades and how the helping hand of Blockchain might be welcome. Generally, in any case, there is a positive leaning towards the benefits of Blockchain.

Using SPSS to analyse the mean scores of the questions in figure 19 against the web survey's baseline questions, the following table presents some highlights that would be worth further investigation, although said investigation is outside the scope of this paper –

| | | Music / Creative Arts | P2P Money Transfer | Politics | Cryptocurrencies | Healthcare | Land Registry |
|---|---|---|---|---|---|---|---|
| **Age** | **18-25** | 3.50 | 4.50 | 4.75 | 3.50 | 4.50 | 4.25 |
| | **26-35** | 4.07 | 4.43 | 4.50 | 3.29 | 4.50 | 4.57 |
| | **36-50** | 3.68 | 4.56 | 4.48 | 3.44 | 4.56 | 4.60 |
| | **50-65** | 4.10 | 4.29 | 4.19 | 2.86 | 4.43 | 3.95 |
| | **Over 65** | 4.00 | 4.00 | 4.00 | 3.67 | 4.33 | 4.33 |
| | | | | | | | |
| **Gender** | **Male** | 3.91 | 4.63 | 4.26 | 3.23 | 4.47 | 4.06 |
| | **Female** | 3.88 | 4.04 | 4.63 | 3.25 | 4.54 | 4.46 |
| | | | | | | | |
| **Education** | **Secondary / High School** | 4.50 | 3.50 | 5.00 | 2.50 | 4.50 | 4.50 |
| | **Certificate / Diploma** | 3.91 | 3.91 | 4.36 | 3.27 | 4.45 | 4.18 |
| | **Undergraduate Degree** | 3.68 | 4.45 | 4.23 | 3.27 | 4.41 | 4.27 |
| | **Post Grad / Masters** | 4.00 | 4.63 | 4.47 | 3.25 | 4.56 | 4.47 |

Points of interest are highlighted in green. The enthusiasm for the application of Blockchain to politics and voting, although high across the board, reduces as the age profile increases. Does this indicate a lack of faith in the political institutions generally, but especially in younger generations?

There is a notable discrepancy between males and females in two questions, P2P (peer-to-peer) money transfer and land registry, with females scoring lower in the former and higher in the latter.

When it comes to the education level of the respondents, the lower the educational level, the higher the enthusiasm for Blockchain solutions, with the notable exception of cryptocurrencies, where high school graduates are noticeably the least enthusiastic. Yet when it comes to P2P money transfers, the higher the education level, the more enthusiastic the respondent became.

As was shown in figure 15 above, it is clear not much is known generally about Blockchain. The informational detail provided throughout the survey and around those questions shown in Figure 19 provided some basic insight to respondents on what Blockchain could do. For many, in light of this new information, this was an opportunity to consider the impact for the first time and determine if it was positive or negative. The response was overwhelmingly positive, which aligns with many of the authors from the Literature review. Tapscott and Tapscott (2016), in their book Blockchain Revolution, paint a picture of a future where prosperity is a possibility for everyone and not just for the wealthy 'elite'. Del Rosal (2015) suggests Blockchain could be the dawn of "an era of irrevocable transparency leading to better democratic structures".

Perhaps it is human nature to be somewhat optimistic regarding emerging technological innovations. This is especially so considering the advances society has made over the four industrial revolutions, detailed in the literature review by Schäfer (2018) and Schwab (2017). However, consideration needs to be given to what preparation is required for technology disruption generally, as detailed by both Brynjolfsson and McAfee (2012) and, specifically for Blockchain, as detailed by Collins (2017).

A final question put to responders, now that there is a modest amount of Blockchain familiarity gleaned from the web survey, pertains to how trustworthy Blockchain will be. That is, do respondents believe it is immutable or 'unhackable'?

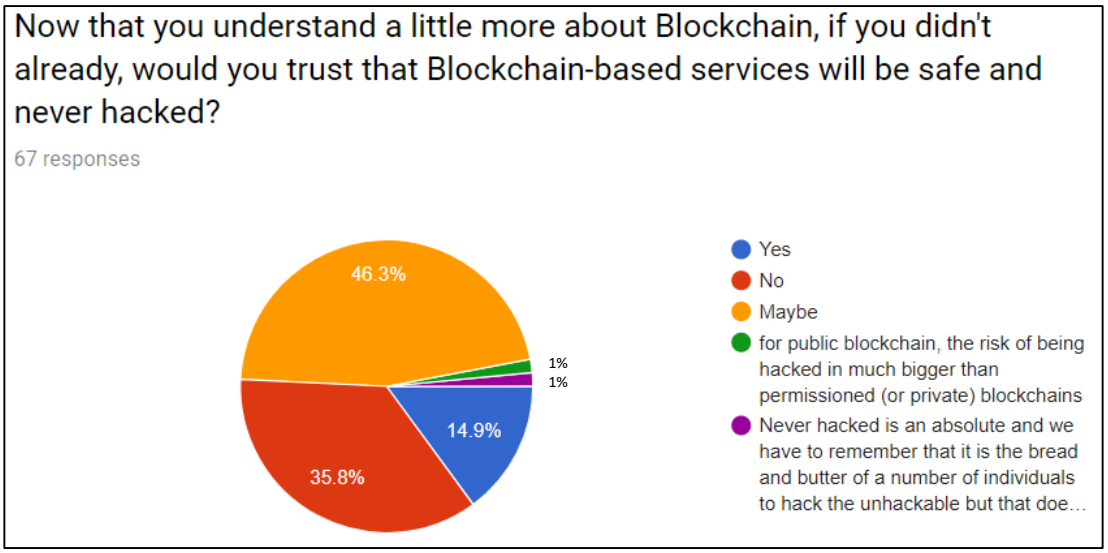


Figure 20 – Views of Specific Blockchain Applications
*Source: Source: Google forms Thesis web survey*

Perhaps unsurprisingly, given the heightened awareness of cyber-security across society today, the response shows a 'healthy' level of scepticism regarding Blockchain's security, with only 14.9% of respondents believing Blockchain-based applications will not be hacked, even if there is a wide level of welcome for the benefits the technology can bring.

Applying SPSS analysis to this question, the following is the result –

| | | **Trust in Immutability** |
|---|---|---|
| **Age** | **18-25** | 2.50 |
| | **26-35** | 2.14 |
| | **36-50** | 2.28 |
| | **50-65** | 2.57 |
| | **Over 65** | 2.67 |
| | | |
| **Gender** | **Male** | 2.40 |
| | **Female** | 2.33 |
| | | |
| **Education** | **Secondary / High School** | 2.00 |
| | **Certificate / Diploma** | 2.18 |
| | **Undergraduate Degree** | 2.27 |
| | **Post Grad / Masters** | 2.53 |

With exception of the youngest age group, trust in Blockchain's immutability increases with age. There is no significant difference between makes in females in terms of such trust. In addition, remarkably, the level of trust in the immutability of Blockchain increases with the level of education. This author postulates that the higher level of education allows for a better understanding of the difficulty in hacking Blockchain.

This concludes the Finding and Analysis chapter. The next and final chapter provides the conclusions and recommendations of this Thesis, building on the findings from the Literature Review and the web survey.

# Chapter 7: Conclusions and Recommendations

## Overview

To this point in the paper, to understand the disruption to society caused by emerging innovative technologies and society's view of said disruption, an in-depth literature review and a quantitative web survey were undertaken. This was followed by an explanation of the research methodology used for the web survey aspect of the research, and finally a detailed analysis of the research findings was presented. To conclude this research paper, the author discusses the subject matter of the thesis, addressing the papers objectives to determine if the research questions were answered in full and how. This section will then conclude with some recommendations for future research in this area.

To review this research paper's objectives one at a time –

1. Review the available literature to gain an understanding of disruptive technology generally and Blockchain specifically. Then, from this review, determine what potential disruptive impacts on society can be expected, both positive and negative.

Both aspects of this objective were achieved in both the literature review and the web survey. A sample of disruptive technologies were reviewed along with specific examples of Blockchain implementations, with the resultant societal impact considered for both. Moreover, potential applications of both were discussed to provide a view of potential forthcoming disruption.

2. Using the findings from the review, and the results of a quantitative web survey conducted on the topic of this thesis, to determine if society is aware of the forthcoming innovations and is prepared for the potential disruption they will bring.

The web survey findings are most pertinent regarding this objective. As has already been started, the concept of disruption from technological innovation is not a new phenomenon and this was borne out from the survey. Respondents, and by extrapolation society, is familiar with the concept and even with almost all of the technology innovations discussed. Blockchain is the only one not having wide

recognition. Even then, once given a brief explanation of Blockchain, respondents were quick to grasp at least initial implications. Clearly, again from the survey, very few would consider themselves experts.

3. Collate recommendations from the review and the web survey on possible courses of action open to companies, governments and societies to prepare for the inevitable technological disruption.

This objective was discussed in the literature review and will be further covered in this chapter under future recommendations. Suffice to say that all objectives were achieved.

The paper's three research questions, generated from the objectives were –

1. What are disruptive technologies generally, and Blockchain specifically, and how do they impact society?
2. Is society aware of the various emerging technologies and is it prepared for their disruptive effects?
3. What must society do to prepare?

For completeness, these will form the next sections of this chapter. Questions 1 and 2 represent the conclusions drawn from the research and question 3 the recommendations.

### Q1 – What are disruptive technologies generally, and Blockchain specifically, and how do they impact society?

A detailed examination of this question was conducted in the Literature review, supplemented with findings from the web survey. David and Philbeck's (2017) depiction of the twelve main innovations facing society provided a very useful framework for this paper, facilitating both the construction of certain web survey questions as well as providing context from which to choose example emerging technologies for the reader to demonstrate potential disruption. The examples chosen, Artificial Intelligence and Robotics / New Computing Technologies, Proliferation and Ubiquitous Presence of Linked Sensors (IOT) and Virtual and Augmented Realities, provided clear examples of how disruptive emerging technologies can be, either individually or together.

Examples of impact included –

- Automation of jobs in industries not normally considered at risk from robotics, AI being the difference, such as the legal profession, healthcare, etc. (Eberhard, Podio et al 2017).
- A paradigm shift in how society interacts with automation and the resultant impact on such industries as car manufacturing or insurance. (Weber, 2017).
- A more data intensive, yet more customised healthcare system. (Demiris and Hensel, 2008).
- Virtual education (Del Rosal, 2015).

Blockchain, one of the twelve identified major innovative technologies (David and Philbeck, 2017) was then reviewed to understand it and its impact on society. Again, once the concept was understood, a number of examples were provided clearly evidencing Blockchain's disruptive potential. They covered potential changes in the handling of creative assets such as music (Raine 2017), tighter and more transparent control of company supply chains (Roberts, 2017), disruption of existing industries (Bridgers, 2017) and digital identity authentication (Hackett, 2017) amongst others.

Question 1 was answered in full.

### Q2 – Is society aware of the various emerging technologies and is it prepared for their disruptive effects?

Both the web survey and the literature review played a role in answering this question. The survey clarified that the sample of respondents and, by extrapolation, society in general, are aware of the disruptive effects of technology innovation. The literature review confirmed that it should not be surprising as it is not a new phenomenon considering society has evolved over the course of three previous industrial revolutions involving technology driven changes. (Schäfer, 2018).

However, awareness of technology disruption does not equate to preparedness and this was made clear by the findings of Brynjolfsson and McAfee (2015) for disruptive technology innovations generally and by Collins (2017) and Iansiti and Lakhani (2017) for Blockchain specifically.

Web survey respondents showed the least amount of awareness of Blockchain specifically. When prompted with the term Bitcoin, the awareness increased, but only of how Blockchain might be used in one instance, not how it works or what other applications might be possible. Certainly, an understanding of societal impact, whilst generally understood when prompted, would not be well known in mainstream society.

The answer to question 2 is, therefore, that society has a general awareness of disruption and is generally optimistic regarding it, but would not be as prepared as it needs to be.

### Q3 – What must society do to prepare?

This is the most pertinent question of the three. At this point, it has been determined that technology disruption is real and it affects societies both positively and negatively. Society is used to such disruption, is aware of most of the emerging technologies even, but it does not fully understand the shape of that disruption until it manifests in their lives. Therefore, policy makers must prepare society for the forthcoming, inevitable, technology-driven disruption.

The literature review identified a number of areas that need to be covered during this preparation. Brynjolfsson and McAfee's (2015) interview with the Harvard Business Review and Del Rosal's (2015) book Disruption highlighted a number of areas policy makers need to consider for technology disruption generally. They include –

1. Education. The skills required by students in the future should include those that enhance creativity, entrepreneurship and problem solving to ensure those students can complete in the workplace of the future.
2. Technological infrastructure. Significant investment in this area is required for societies to be successful in a heavily technological world.
3. Entrepreneurship. This needs to be a focus for national governments right now.
4. Immigration. A difficult topic in global politics today, but one pertinent for the future of western societies. Immigrants come with new ideas for business

and are generally a good source of jobs. They also assist those economies maintain a level of taxation required to support an aging population.

5. Research and Development. Governments worldwide need to increase their investment in R&D activities to encourage companies to take part in such programs.
6. Universal Basic Income. Companies and Industries need consumers with disposable income to buy their products and services otherwise they fail. Del Rosal (2015) believes governments are going to have to consider guaranteeing members of society a basic income regardless of if they earn it or not.

The above points may appear to be somewhat obvious but there is an important aspect to them that may be overlooked. Moore (1965) originally predicted that computers would become more powerful at an exponential rate and this improvement in technology is borne out in the findings from many of the authors listed in the literature review such as Del Rosal (2015), Davis and Philbeck (2017) and Schäfer (2018). The clear implication is technological disruption is fast approaching, in fact has already begun, which means the above changes should already be in place. However, they are not. Governments need to ramp up their respective responses to the forthcoming disruption now if they want their societies to thrive and avoid the technological, economic and social dislocation foreseen by Schäfer (2018).

The same points can be made for Blockchain, the technology least familiar of the emerging technologies. Collins (2017) counsels caution when considering and preparing for Blockchain's impact. It is true there is much hype surrounding the technology, but it is real and is disruptive. Collins' (2017) advice regarding Blockchain can be applied to any emerging technology... Remain level-headed, understand the technology and its application and react appropriately. In addition, consider the unintended consequences of preparing for and applying these new emerging technologies. Iansiti and Lakhani's (2017) measured approach is a good guide for policy makers.

Regulation is the final area to be considered. New technologies can bring great benefits, but they will also bring new ways of doing business, disintermediation and

potentially less privacy. Policy makers' approach to emerging innovations requires careful consideration of these points. An example reviewed above is GDPR; how is a person's 'right to be forgotten' upheld if companies and governments implement an immutable Blockchain technology? New technology will bring with it a quest for new solutions, which will in turn bring further new technological innovations… a never-ending cycle.

## Future Research Possibilities

The time constraints associated with this research paper dictate that a cross-sectional approach be taken in terms of the time horizon (Saunders et al, 2012). However, as it is recognised that society is entering into the fourth industrial revolution, it might be worth considering a longitudinal approach to study the effects of technology disruption over time and to review action taken by policy makers to prepare for the inevitable disruption and if that action was successful.

Blockchain itself requires a lot more in-depth research to better understand what it can be applied to and how to overcome the challenges mentioned above, such as regulatory oversight. Collins (2017) sceptical view of the hype surrounding Blockchain might be too sceptical, but it does demonstrate a divergence of opinion on the potential of the technology. Therefore, further research is recommended.

The web survey conducted for this research paper did throw up a number of interesting items with regards to age, gender and education, and the awareness and acceptance of emerging technology, that are worth further investigation. The specific points are made in the findings and analysis chapter.

As a final point from this author, society should remain optimistic. The literature review and the survey revealed it is part of human nature to lean towards optimism and this author believes it to be true. Humanity found a way to evolve through three industrial revolutions, there is no reason to believe we will not find a way through the fourth.

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## Appendix A – Questionnaire

# Technology Disruption: Is Society Prepared for Blockchain?

This is an anonymous survey being conducted in support of an MBA Thesis

The survey concerns understanding the disruption to society caused by the introduction of new technologies, using Blockchain as an example.

Blockchain is a shared, global distributed ledger that can be used to keep an accurate, validated, immutable and safely encrypted record of any asset that can be digitised. It has the potential to "virtually record everything of value and importance to humankind" (Tapscott and Tapscott, 2016), allowing transactional interaction directly between parties without going through intermediaries such as banks, aggregating companies or government institutions.

The hypothesis is that most people are unaware of disrupting technology before it arrives and cannot fully understand how it will affect society, including themselves until it does. Using Blockchain as an example, the questionnaire is designed to gather data supporting this.

*Required

## Baseline Questions

Your responses will remain anonymous, only to be used as part of a National College of Ireland MBA Dissertation on the titled topic.

### Age range *

- ◯ Under 18
- ◯ 18 - 25
- ◯ 26 - 35
- ◯ 36 - 50
- ◯ 50 - 65
- ◯ Over 65

### Gender *

- ◯ Female
- ◯ Male
- ◯ Other

Education level attained *

- ○ Secondary / High School
- ○ Certificate / Diploma
- ○ Undergraduate Degree
- ○ Post Graduate / Masters Degree
- ○ Doctorate / PhD

## Disruptive Technology

The term Disruptive Technology refers to the development and implementation of technology that has a disrupting effect, often negative, on existing products & services being provided by companies or individuals. For example, the arrival of Uber's idea of matching people who need a ride/lift with drivers who wish to provide that service through a peer-to-peer application has had a significant disrupting effect on incumbent taxi companies in cities Uber is operating.

Have you heard of the term 'Disruptive Technology? *

- ○ Yes
- ○ No
- ○ Not Sure

Have you heard of any of the following disruptive technologies? *

- ☐ Artificial Intelligence
- ☐ 3-D Printing
- ☐ Robotics / Automation
- ☐ Autonomous Vehicles
- ☐ Flying Drones
- ☐ Internet Of Things
- ☐ Virtual / Augmented Reality
- ☐ Biotechnology
- ☐ Alternative Energies
- ☐ Blockchain
- ☐ Other: _____

Do you welcome such technological innovation? *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not at all | ○ | ○ | ○ | ○ | ○ | Completely |

In terms of Impact on society, would you say Disruptive Technologies are... *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Completely Negative | ○ | ○ | ○ | ○ | ○ | Completely Positive |

What types of societal impact would concern you? *

- [ ] Loss of Jobs
- [ ] Increased Growth of Wealth Inequality
- [ ] Offshoring of Local Jobs
- [ ] Lack of Skill & Training Required for New Job-types
- [ ] Increased Cost of Living
- [ ] Increased 'Big Brother-type' Intrusion
- [ ] Control of Artificial Intelligence
- [ ] Other: _____

Do you foresee any benefits for society from disruptive technology innovation? *

- [ ] Bringing People Closer
- [ ] Enhanced Quality of Life
- [ ] Providing Opportunities for Third-World Countries
- [ ] Better Government / Politician Accountability
- [ ] Better Standard of Living for All
- [ ] More Efficient Society
- [ ] People have more Control over Their Own Personal Data / Records
- [ ] Other: _____

## Blockchain General

As stated above, Blockchain is a shared, global distributed ledger that can be used to keep an accurate, validated, immutable and safely encrypted record of any asset that can be digitised. It has the potential to "virtually record everything of value and importance to humankind" (Tapscott and Tapscott, 2016), allowing commercial interaction directly between parties without going through intermediaries such as banks, aggregating companies or government institutions.

### Are you familiar with Blockchain? *

- ○ Not At All Familiar
- ○ Slightly Familiar
- ○ Moderately Familiar
- ○ Very Familiar
- ○ Extremely Familiar

### In what context have you heard of Blockchain *

- ☐ Bitcoin or other Cryptocurrencies
- ☐ Fintech
- ☐ Secure Recording of Digital Assets such as Music, Books or Other Creative Assets
- ☐ Micro-lending / Payment Networks
- ☐ Healthcare – Patient Records
- ☐ Register of Electors / Voting
- ☐ Identity Authentication / Management
- ☐ Land / Title Registries
- ☐ Notary Publics
- ☐ Supply Chain Tracking
- ☐ Healthcare Patient Records
- ☐ Smart Contracts
- ☐ I have never heard of Blockchain or I don't know anything about it
- ☐ Other: _____

Which of the following Industries do you think Blockchain will be disruptive to ? *

- [ ] Financial Services
- [ ] Government & Public Service
- [ ] Transport & Logistics
- [ ] Legal Profession
- [ ] IT / IT Security
- [ ] Academic / Research
- [ ] Energy
- [ ] Intellectual Property
- [ ] Music
- [ ] Patents
- [ ] Other: _____

What might be the barriers to the use of Blockchain? *

- [ ] Reluctance / Refusal of Companies to use Blockchain Technology
- [ ] Lack of Compatibility with Existing Systems
- [ ] Lack of Inter-operability with/between Third Parties Providing Services
- [ ] Lack of Trust
- [ ] Perceived Data Security
- [ ] Apathy
- [ ] Lack of Clarity on Return On Investment
- [ ] Legacy Infrastructure & Apps
- [ ] Immature / Unproven Technology
- [ ] Lack of Government Oversight / Regulation
- [ ] Other: _____

## Blockchain Specific

Using specific examples of how Blockchain can be used, the remaining questions are designed to understand how your view of Blockchain changes for better or worse, the more you know what it can do.

Music / Writers - Artists will ensure copyright & appropriate royalties for their creations whilst preventing piracy or unlicensed sharing. *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Hate it | ○ | ○ | ○ | ○ | ○ | Like it |

Peer-to-peer money transfer - People will transfer money to one another, or make payments, without the need for an intermediary institution like a Bank or Clearing House. *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Hate it | ○ | ○ | ○ | ○ | ○ | Like it |

Politics - Immutable voter registration records prevent election corruption and will allow safe online elections / referenda *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Hate it | ○ | ○ | ○ | ○ | ○ | Love it |

Cryptocurrencies - Online currencies based on Blockchain technology can replace the existing system of fiat currencies (e.g. Euro / Pound / Dollar / etc.) *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Hate it | ○ | ○ | ○ | ○ | ○ | Love it |

Healthcare - Encrypted patient records become the sole property of the individual, who can make them available to whichever Healthcare professional is treating them. *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Hate it | ○ | ○ | ○ | ○ | ○ | Love it |

Land Registry - Title to land can be irrevocably recorded preventing people losing their title in areas of the world where government corruption is common. *

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| meh | ○ | ○ | ○ | ○ | ○ | Go Blockchain! |

Now that you understand a little more about Blockchain, if you didn't already, would you trust that Blockchain-based services will be safe and never hacked? *

- ○ Yes
- ○ No
- ○ Maybe
- ○ Other: _____

**Thank You**

Thank you for taking the time to participate in this survey. It is much appreciated.

SUBMIT

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