Chapter 4: Technology Challenges in Accounting and Finance

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4.1 Introduction

The aim of this chapter is to introduce some of the many technological developments that are shaping the world of the accountant; Big Data, Cloud Computing, Artificial Intelligence and Blockchain. The focus of this chapter is to explain the effects of these emerging technologies on the role of the accountant from the standpoint of a management accountant working within a business or a financial accountant working either in practice or within a business.

In recent years, Big Data has transformed the business world and it has impacted both organisations and individuals. Huge datasets of structured, semi-structured and unstructured data gathered from sources such as the internet, telecommunications and Global Positioning Systems continue to grow second by second, creating a rich data source on virtually every aspect of life on the planet. This data is of immense value to businesses both for commercial reasons but also for developments within the worlds of medicine and science. It is vitally important that accountants understand the implications of this vast data in their own jobs and environment.

Linked to Big Data is the development of cloud computing, which allows businesses to pay for data storage and computer applications as they need them on the internet, which has the potential to save considerable sums of money, but brings with it data security issues for accountants.

The chapter also discusses how artificial intelligence (AI) is influencing business in its ability to carry out routine processes, but also to learn how to spot trends and interact with humans. Whilst still in its infancy, AI has the potential to transform many business processes, but we should be wary in relinquishing total control to machines until some of the broader implications of this technology have been adequately assessed.

Finally, this chapter provides an introduction into another potentially hugely disruptive technology, that of blockchain. It discusses the principles behind blockchain and how it is already supporting the world's largest cryptocurrency, Bitcoin, but also how the technology itself is likely to transform the accounting and finance discipline in the future.

The chapter provides suggestions to (future) accountants on issues they may need to consider in their personal development and training in order to be equipped to leverage the benefits and challenges that these new technologies will bring.

4.2 Big Data

4.2.1 What is 'Big Data'?

The term "Big Data" emerged at the turn of the new century. As the name implies, it is a very large collection of records, some of which are unstructured such as images and which are too large to process using basic database management tools.

"Big data refers to the explosion in the quantity (and sometimes quality) of available and potentially relevant data. In this new and exciting world, sample sizes are no longer fruitfully measured in "number of observations" but rather in, say, megabytes" (Diebold 2003 p.116).

Over the course of the 21st Century there have been many advances in computer technology. Computer system hardware and bespoke software packages have become affordable to the smallest of companies. As more businesses have adopted computer systems, there has been a surge in the volume of data being recorded digitally. A simple example of this in the retail environment is EPOST (Electronic Point Of Sale Terminals) and the more advanced EFTPOS (Electronic Funds Transfer Point of Sale) Terminals which record details about consumer purchases and behaviour from scanning barcodes of purchases and the checkout, and which are expected to increase in significant numbers in the next few years (Acute Market Research 2017). Additionally, cheaper digital storage developed in recent years has meant that more data can be stored (Russom 2011), whilst advances in software meant that this data could be retrieved and sorted with relative ease with the use of spreadsheets or database tools. Analysing data has become relatively quick and easy, particularly compared with manual record-keeping, however it is often challenging to manage the sheer volume of data and gain any meaningful insights (Sundaresan 2008). This proliferation of data from retail terminals, internet, mobile phone and social media activity, radio frequency identification (RFID) tags, business data feeds and Global Positioning Systems (GPS) to name just a few data sources, has created huge datasets which are referred to generically as 'big data', because of their size, which is often measurable in terabytes, or increasingly, petabytes or exabytes of data (Marr 2017).

By its very nature, accounting is "concerned with collecting, analysing and communicating financial data" (Atrill and McLaney 2017, p.1). Arguably it is the original "Big Data" in any organisation. Historically, the financial accounting records were kept manually. For a large organisation this could mean rooms of people writing in ledgers. Extracting the details to construct a set of financial statements was a time-consuming task. Over the past 40 years, the process of recording records for financial accounting has been transformed by the use of computers. The collection and storage of records has become digitised. Double entry book keeping records are automatically generated. Software will produce an income statement and statement of financial position on demand.

Hence the role of the accountant is changing. There will always be a need for financial accountants to ensure companies comply with legislation and accounting standards to assure users of financial statements about the underlying performance of the business. Large organisations will still need financial accountants working internally to decide how best to account for different transactions and to continue to interact with other parts of the business. For the financial accountant working in practice, the nature of their work has changed as the nature of the economy has changed. Hence the financial accountant has less work to do in terms of gathering the financial data when computer systems such as Sage, Quickbooks and Xero are used by so many businesses. However, they now need to be able to handle much larger quantities of data and spot issues and trends in that data.

In a similar way to the changes to financial accounting, the function of the management accountant is changing. As reports become automated, the role is to provide better support for decision making and performance management. The production of standard reports (such as end-of-month financials, variance analysis, Key Performance Indicators (KPIs) and regulatory filings) is becoming ever more automated. At the same time, due to the competitive environment, demand is growing for management accountants to provide ongoing ‘insight’, not from financial data on its own but in combination with non-financial data as well, both internal and external to the business and sometimes including ‘Big Data’ (Simons, Masamvu, and Parks 2013).

4.2.2 Where does Big Data come from?

Data collection and storage has been increasing exponentially over recent years. “According to IBM, companies have captured more data in the last two years than in the previous 2000 years” (Syed, Gillela, and Venugopal 2013, p.2248) and this trend has continued. Data is collected from virtually every transaction undertaken, sometimes without any human interaction at all. This can come from:

- activity data, such as reading eBooks or making a purchase on a credit card;
- conversation data, such as phone calls, Facebook and Twitter conversations;
- photo and video image data, such as the thousands of photos and videos uploaded from cameras, phone and even CCTV daily;
- sensor data, such a GPS sensor tracking movements; and
- internet of things (IOT) data which comes from smart TVs, fridges, watches and alarms (Marr 2017).

Data collection in business is often used for marketing purposes (Michael and Miller 2013). The EPOST system introduced above can be extended with a customer loyalty card. For example, the Tesco Clubcard records personal information from the moment a customer provides personal details on registration and it is continually added to through data gathered on the card about where you shop, when you shop, items that you buy, the method of payment and more. This allows for targeted marketing to be carried out (Atkins, Kumar, and Kim 2016). Equally, data is being constantly collected about you, your location and your preferences on the internet through shopping websites (for example, Amazon) or search engines (such as Google) whether through your computer or phone, even when you may not be aware of it (Collins 2017). Again, this information can be used to target you for particular products or services or to provide a rich dataset about consumer habits and preferences.

These purchasing activities can be linked through the supply chain, to pull inventory through the system once supplies are low or orders have been placed as part of a Just In Time (JIT) inventory management system. This can often be supported by other tracking devices or sensors, such as radio frequency identification (RFID) tags which, together with GPS can monitor the movement of inventory throughout the supply chain, enabling it to be sent wherever it is needed (Want 2006).

4.2.3 Making sense of Big Data

In order to make sense of Big Data, various authors have defined terms which explain its dimensions. Whilst there are various interpretations of them, the most commonly used are the ‘V’s: Volume, Velocity, Variety, Veracity and Value (Laney 2001; Tom Shafer 2017; Marr 2017), which we will now explain in a little more detail:

4.2.3.1 Volume

In the early 2000s, Diebold (2003) discussed measuring data in megabytes. Megabytes or MB are 1,024KB which are 1,024 bytes; a byte is 8 bits of data in binary code. A character is a byte. A kilobyte is a long paragraph. A megabyte might be about 4 books (plain text). A gigabyte or GB is 1,024 megabytes. A GB could be about 4000 books and terabytes are 1,024 GB. The list of terms continues to grow (such as petabytes and exabytes), like the data it describes. To put this into context, in the year 2000 the 3.5 inch floppy disk which held up to 1.44MB of data was being phased out by re-writable CD holding 650MB. The modern USB flash drive can hold from 1GB to 128GB and beyond. A 2 terabyte version is now available and Google routinely provides its users with 15GB of free cloud storage. It was estimated in 2012 that about 2.5 exabytes of data were being created daily, and that figure doubles approximately every 40 months (McAfee and Brynjolfsson 2012).

For the accountant, this means that there is a huge amount of data available to work with. In terms of financial accounting this data needs to be sorted into the financial transactions that are required to construct the published accounts. Arguably one set of accounts is not big data. But the accounts of all UK companies would be. For the management accountant, there are endless possibilities to use vast data sets (both internal and external to the company) to inform management and aid in decision making.

4.2.3.2 Velocity

This is the rate at which data is generated on a continuous basis and processed in "real time" (Laney 2001). From a financial accounting perspective, this ability to process data in real time makes the production of the published accounts much faster. For the management accountant the month end process can be completed quickly, allowing better business decisions to be made. For example, if the report is produced two or more weeks after the month end and there are problems these can be up to six weeks old which can be detrimental to business performance. Identifying a problem sooner rather than later can make a difference to a business. This affects all areas of the company, not just accounting.

4.2.3.3 Variety

Data comes in many forms and from a range of sources. As mentioned earlier, data can be structured or unstructured. For example, a database is usually structured but the content of an email is often unstructured. Estimates from Cisco and IBM suggest that 90% of all data is unstructured (Cisco 2014). As more data is collected from different sources, the variety of data increases (Marr 2017). The problem then becomes extracting and making sense of the relevant data from these different sources (Marr 2017; McAfee and Brynjolfsson 2012). In many cases, humans are actually better at this than computers. For example, if a company receives two different invoices from two suppliers, a human will easily recognise the key features where a computer will still occasionally make a mistake, for example not being able to identify the company name from a logo or reading a phone number as an invoice number. Conversely, computers are much better at sifting through data and searching for items if it is in a particular format: however, Big Data does not eliminate the need for vision or human insight (McAfee and Brynjolfsson 2012).

For the financial accountant, data has always arrived in different forms. A shoebox of receipts, a spreadsheet of clients, a box of invoices. For the financial accountant in practice, the client will usually have collated the data beforehand, either manually through inputs in a spreadsheet or by using software which can link to bank accounts to instantly summarise the cash position of the business. For the management accountant, the variety of data poses a challenge in terms of the extraction of relevant information. Receiving data from multiple sources means time must be taken to collate the data and present it in a manageable format. This is made more challenging as management accountants also typically deal with non-financial data as well as financial data.

4.2.3.4 Veracity

This relates to how ‘messy’ or trustworthy data is, given the multiplicity of sources from which it comes and the forms it takes (Marr 2017). All data must be reliable, particularly if it is being relied on to make decisions. As data collection becomes more autonomous, it could be argued that the human error element is being removed. However, where data comes in a variety of formats, collating the data into an understandable format adds a step which can reduce the reliability. Both humans and computers can (inadvertently) introduce errors, for example, voice recognition software which incorrectly interprets a speech pattern or accent.

For the financial accountant, data must be accurate and be reflective of the true performance of the company; the audit process (by having an independent review of the underlying figures and assumptions behind the financial statements) does add to the validity of the financial accounts, although even this is not infallible. For the management accountant, the quality of business decisions taken depends upon the validity of the data which underpins those decisions.

4.2.3.5 Value

Now that it is relatively inexpensive and straightforward to collect data, the challenge lies in analysing, spotting trends and interpreting the data to make sense and value from it. The sheer volume of data that has already been collected is staggering and very little of it is either being analysed at all or is not being analysed in ways which would allow companies to gain valuable insights from it (Sundaresan 2008; Jagadish et al. 2014). However the ability of firms to exploit business information and analytics is now perceived to be a key differentiator in a competition world, such that those who are skilled at it have used it to transform their businesses (Jagadish et al. 2014).

Whilst the datasets that the average financial accountant will be using will be small, the management accountant may well be tasked with looking at much larger datasets to spot trends, identify opportunities and support strategic decisions; this will require substantial data analytic knowledge and the support of additional data analysis tools beyond basic spreadsheets. It can also require a substantial change in mind set in firms to move from human experience to data-driven analytics to make decisions (Sundaresan 2008; Jagadish et al. 2014).

To elicit value from Big Data, firms need to invest into specialist data analytical tools, because they are designed to cope with the volume and variety of data which is now available, both in terms of storing the data but also in decoding it and manipulating it. There are various names of packages to support this such as Hadoop, HBase and Hive (Sagiroglu and Sinanc 2013). These packages carry out complicated searches of the data using such techniques such as text analytics (for standard, structured data), face recognition (for image and identifying people), sentiment analysis (using key words used in social media messages to ascertain people’s attitudes to certain things), and voice analytics (again to determine attitudes as well as content) of voice messages (Marr 2017). This can be used to predict new trends, highlighting products that could sell well in the future. However it is important to remember that this knowledge can only be of use if there is a clear link between the opportunities which Big Data provides and the strategy of the firm (Jagadish et al. 2014).

4.2.4 The application of Big Data

Apart from the marketing purposes and logistics purposes discussed above, Big Data can be used in medical disciplines by understanding disease and symptoms patterns (Michael and Miller 2013), including any links between lifestyles and health (Jagadish et al. 2014) or in the security services to track patterns of behaviour relating to terrorist activities (Marr 2017). It can be used to track traffic patterns in cities to ease traffic flow and design new public transport services around key areas of congestion (Marr 2017; Jagadish et al. 2014). Other uses include environmental modelling and even astronomy (Jagadish et al. 2014).

4.2.4.1 Big Data in Accounting

Accounting itself is the collection of data and the process of transforming that data into useful information. For the Financial Accountant, this is the production of the financial statements. For the Management Accountant, this is the production of monthly reports or financial information for projects. Although much of this will not change with Big Data, management accountants in particular will need to become more able to work with larger datasets with potentially new analytical tools than they do currently. This should complement the skills that most accountants have, to be enquiring and not afraid to challenge the sources of data and the analyses that have been carried out on it, to ensure that decisions based on it are reliable (McAfee and Brynjolfsson 2012). This does not mean that they will need to become data programmers themselves, but to have enough knowledge to be able to act as a bridge between the technical team and the rest of the business. As Simons, Masamvu and Parks (2013, p.3) stated:

> *'To truly unlock the opportunities in big data, management accountants will need to partner more closely with three sets of key stakeholders: their colleagues in IT who capture much of the data; the data scientists who can perform advanced types of analysis on that data; and finally business leaders who can ensure new ideas are turned into concrete action. This requires financial professionals to have a broader range of management skills: clear communication, the ability to lead and influence, and a strategic understanding of the business – all of which are essential for the business partnering role that many firms want finance to play.'*

Big Data is already having and will continue to have an impact on business, leading to more accurate insights into the business environment and the changes happening within it. It will allow for better planning and forecasting, the identification of the root causes of costs in businesses, it can help detecting fraud and identifying risks and opportunities (Russom 2011), all activities in which accountants will need to be involved (Simons, Masamvu, and Parks 2013).

4.3 Cloud Computing

4.3.1 What is “Cloud Computing”?

Linked to Big Data is the development of cloud computing. Cloud computing is simply a system of storing data and accessing processing applications on-demand through the internet (the word ‘cloud’ referring to the internet (Bhardwaj, Jain, and Jain 2010)) rather than using the limited memory capacity of one’s own device or network (Zhang, Cheng, and Boutaba 2010). As defined by the US National Institute of Standards and Technology (2017):

> *‘Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction’.*

As the amount of data captured and stored has increased exponentially over recent years (see section on Big Data above), there is an increasing demand for more storage. Any single computer or network has a limited capacity of memory for storage, so rather than having to invest in large storage systems (Armbrust et al. 2010), end users can lease what space and applications they require as their needs change and then retrieve data and services when needed over the internet.

There are generally two service providers in cloud computing, the infrastructure providers who manage the cloud platforms (often referred to as ‘Infrastructure as a Service’ (IaaS) (Bhardwaj, Jain, and Jain 2010)) and lease space to service providers. This service includes management of computing power and memory and data storage in data centres. The service providers in turn lease the services required to end users (for example, businesses or individuals) (often called ‘Software as a Service’ (SaaS)) (Zhang, Cheng, and Boutaba 2010; Bhardwaj, Jain, and Jain 2010). Examples of this include business applications and web services, such as Google Apps and Facebook. In between these two levels is a third level called ‘Platform as a Service’ (PaaS) (Armbrust et al. 2010; Bhardwaj, Jain, and Jain 2010) which provides operating system support and software frameworks needed by developers to develop applications based on technology such as .Net and Java, to provide services like Microsoft Azure or Google AppEngine (Liu, Yang, and Qu

2016). From an infrastructure point of view, the benefits of cloud computing are lower operating costs since resources can be quickly reallocated to manage demand and it is highly scalable as infrastructure providers can pool resources easily (Zhang, Cheng, and Boutaba 2010; Armbrust et al. 2010). For businesses, applications and data can be easily accessed on a wide variety of devices such as phones and tablets anywhere, rather than just through a networked office-based computer (Bhardwaj, Jain, and Jain 2010). This reduces business risk since the risks of hardware failures are passed to the infrastructure providers who may have better skills to manage them and from a service point of view, the cost of updates, maintenance and staff training are reduced as a result of the sharing of these costs across many end users (Zhang, Cheng, and Boutaba 2010).

From an accountant's and a business' point of view, cloud computing is undoubtedly a useful way in which to manage Information Technology (IT) resources as firms pay for the services as they use them, rather than in a single investment and they can store as much data as they need (Bhardwaj, Jain, and Jain 2010). It can also be a source of competitive advantage by collaborating with other firms across supply chains (Liu, Yang, and Qu 2016). However, the biggest concern around cloud computing is that of data security. As potentially all of a company's data could be held physically distant from the company in large data centres, businesses are dependent on the infrastructure provider to ensure data and access is both fully secure and auditable. These infrastructure providers must produce evidence that data is held confidentially (usually through some form of cryptography), and that there are robust safeguards around data access and transfer. Equally, they must be able to demonstrate that any security settings have not been altered without sufficient authorisation.

For accountants, as firms become more reliant on cloud-based IT with their business-critical data held in third party (cloud) depositories, data security, business continuity and service availability are areas of crucial concern (Armbrust et al. 2010). To date, cloud services have been very robust and highly available (Armbrust et al. 2010), although this will need to be continually monitored as firms seek to ensure that business risks are appropriately managed.

In terms of data storage, new legislation (such as the General Data Protection Regulation (GDPR) in Europe (EU Parliament 2016)) keeps evolving to manage the rights of individuals whose data is kept in corporate databases. This legislation restricts the transfer of data across international boundaries and puts in place rules about the kind of data which may be kept, how long for and for what purposes. This clearly affects where firms (in particular, multinational corporations) may keep their data centres. Since the fines associated with breaches in these data protection regulations are becoming increasingly onerous, it is vital that accountants are aware of the impacts of distributed or cloud-based IT on corporate costs and risks.

4.4 Artificial Intelligence

Artificial Intelligence (AI) is defined as 'computational systems that attempt to mimic aspects of human intelligence' (Seshia, Sadigh, and Sastry 2016), in other words, it is the idea of a machine or computer having human-like intelligence in order to learn, problem solve or take decisions.
The concept has been around since the 1950s (Kiruthika and Khaddaj 2017), first appearing in novels and movies and now becoming a real part of our lives, although perhaps not in the way the movies portrayed. It is embedded within self-driving cars, digital personal assistants such as Cortana and an AI computer has even won a game show (Jeopardy!) (Hawking, Tegmark, and Wilczek 2014). AI has the capacity to outsmart financial markets and produce new inventions, and ultimately may be of substantial benefit to humankind if it is able to cure diseases or solve social problems, but it needs appropriate controls to ensure that ultimately poor decisions are avoided (Hawking, Tegmark, and Wilczek 2014; Russell et al. 2015). Although AI is already capable of allowing machines to take decisions, this raises the ethical question: to what extent should humans allow them to do so without human intervention? This is particularly of concern in applications such as autonomous weapons systems which could select targets and engage with them without any human intervention and which to date, have been condemned by the UN (Russell et al. 2015).

Developments in AI currently are focused on building systems that are capable of thinking as good as, if not better than, humans, including both intelligence and reasoning (Kiruthika and Khaddaj 2017). This is done by building algorithms to 'teach' computers to learn using a system of training, historic and live data. Any patterns which are learnt by the computer are stored and when similar situations arise again, the computer uses its knowledge of the previous pattern to make the appropriate decision (Kiruthika and Khaddaj 2017).

There are three types of AI: process automation, cognitive insight and cognitive engagement, which will now be discussed. The main potential benefit of AI in the business world and the one most likely to impact on accountants is process automation (also known as robotic process automation), such as invoice processing (Castelluccio 2017), updating changes of address records, replacing lost credit cards and 'reading' legal documents (Davenport et al. 2017). AI can also be used to detect patterns in vast quantities of data (such as Big Data) by the use of computer algorithms – this is cognitive insight AI (Davenport et al. 2017). This could assist in the prediction of customer demand for products, targeted marketing, the identification of fraud, analysis of warranty data and other similar processes where trends could be found. The final kind of AI, cognitive engagement, is where computers are able to engage with humans, such as employees or customers using natural human language, such as on chatbots. Clearly this has the potential appeal for firms to have customer service, employee support programmes or health advice services available 24/7, but the technology is still not reliable enough to be extensively deployed at the current time, although doubtless this is an area of significant future growth (Davenport et al. 2017).

Despite the hype around AI, few businesses outside of the technology sector currently use it significantly, although that number is increasing as the technology is developing (Bughin, McCarthy, and Chui 2017). Very large technology firms are clearly engaging in it since it will provide competitive advantage for them: internet search engines Google and Baidu both spend billions of dollars on research and development into AI (Castelluccio 2017). One example of an AI-enabled business application is behavioural analysis of potential customers when being asked to evaluate a new product. AI, together with other forms of technology, such as virtual reality, can elicit feedback from clients and their interaction with a potential new product and then use this to improve the product or to improve training or instructions for its use (Kiruthika and Khaddaj 2017). This has the potential to avoid wasting money on taking poorly designed products to market. It is also likely to improve sales and profit margins (Bughin, McCarthy, and Chui 2017). AI has also been used by a cancer centre in the US to recommend hotels for patient's families, identify which patients might need help paying their bills and solving other IT problems (Davenport et al. 2017). Whilst this may not seem revolutionary, it has improved the quality of life for many patients and is a tangible benefit of the technology. It may be initially the more repetitive and incremental applications of AI which will yield the initial impacts on business, but is likely in the long run to be a very disruptive but beneficial technology if the ethics of control are developed as well as the technology itself.

4.5 Blockchain

Blockchain is potentially a fundamental game changer in many spheres of digital life in the future. In the same way that electricity enabled telecommunications across the globe (McPhee and Ljutic 2017), blockchain has the potential to transform the way of doing business and interacting with other people globally in the future.

The most well-known use of blockchain technology currently is as the technology underpinning cryptocurrencies, which are currencies which operate online, without physical presence and without the support of any one nation or institution (like a bank). Bitcoin was the first of such currencies, launched in 2009 by an unidentified person or group of people under the name of Satoshi Nakamoto (Nakamoto 2008) and it allows payments to be made globally using the virtual currency, where transactions are recorded on a decentralised public register. It is currently the largest public blockchain in commercial use (Swan 2015). By using blockchain, it is possible to move money across the world almost instantly and at low cost without the need to pay fees to a bank or wait for their internal processes to move the money around, which can often take days (Swan 2017).

4.5.1 What is blockchain?

Essentially, a blockchain is a network software protocol, which is a set of rules and conventions which allow network devices (for example, computers) to communicate with each other (ICAEW 2017). A protocol specifies how devices are recognised and connected to the network and how data is formatted, packaged and sent between network devices. When data is packaged and sent over the network, it includes a small header and footer at the beginning and end of the data package to identify the sender and intended recipient of the data package. What differs with blockchain compared with other protocols is that these headers and footers are converted into cryptographic signatures or 'hashes' which makes the likelihood of anyone tampering with the data virtually impossible.

Cryptography is a method of converting, storing or transmitting plain text in a form so that only those for whom it is intended are able to read it (Stinson 2006). As such it prevents data from being altered or stolen and aims to maintain confidentiality whilst authenticating permitted users. There are various techniques employed in cryptography, such as symmetric key (where the sender and recipient possess the same key to both encrypt and decrypt the message before and after transmission of the plaintext), public-key (where the public key is widely distributed and is used to encrypt, but the private key used to decrypt is held secretly) and cryptographic hashing (where a fixed length hash value (a random collection of symbols) is embedded within the plain text) (Stinson 2006).

Transactions on a blockchain (for example, a series of financial payments) are comprised of a series (or chain) of blocks of data and information which are linked to each other by these cryptographic 'signatures' or hashes which link the last block with the next one. Each block is date and time stamped and blocks are added chronologically to the chain (Swan 2017). This updating is done by the devices attached to the blockchain, called 'nodes' or 'miners'. A miner takes the hash from the last block in the chain and the new transactions which need to be added to the chain. The miner then 'hashes' this to match with the previous block once the transaction is authenticated and the new block (to record a new transaction) is added to the chain (Swan 2017). As transactions (or blocks) happen through the course of time and are added to the blockchain, then it grows in one direction. Once added the block is irrevocable. If a change needs to be recorded (for example the ownership of an asset needed updating), then a new block must be added to the chain (McPhee and Ljutic 2017). This creates an everlasting ledger of all transactions, which makes it eminently suitable to financial accounting records and the possibility of perpetual audit (Peze 2017).

Any authorised device granted access to the blockchain receives a copy of the entire blockchain, from the first initial block (called the genesis block) to the latest block to be added, hence why blockchain is also referred to as a 'distributed' ledger technology: any changes made to the blockchain must be agreed by all participants who are allowed access to the chain and all transactions are visible to all (Swan 2017, 2015). All participants in the blockchain receive a copy of the whole blockchain and this is what makes it inherently different to other technologies – all transactions are seen and verified by all and no one person or organisation keeps a central copy – copies are updated and distributed approximately every ten minutes (depending on the kind and complexity of transactions in the blockchain).

By having this decentralised ‘peer-to-peer’ approach reduces the need for the ‘middle man’ such as brokers and potentially even governments (Wright and De Filippi 2015). Until blockchain technology emerged individual transactions over the internet needed to be validated by a central authority, but that is no longer the case. This distribution of data also effectively eliminates the need for a central repository of data (for example, a bank (Swan 2017, 2015)) which can reduce cost and improve security as it is impossible for a hacker to gain access to and change the data from a single point of access (and failure) (McPhee and Ljutic 2017). This can facilitate the transfer of assets and information securely and more quickly than is currently the case when having to rely on the action of an intermediary such as a bank to validate the transaction and store records (Swan 2015, 2017).

4.5.2 What are the potential benefits of blockchain?

Technologies based on blockchain are likely to drive efficiency and improvements in service delivery in both the public and private sector, due to their ability to verify and authenticate transactions and identities, leading to enhanced trust between service user and service provider (Wolfond 2017). The capability to verify genuine users and prevent fraud is a key strength in blockchain technology and it should lead to easier-to-use experiences for the user interacting with the service and reduce transaction costs for the provider.

One of the biggest advantages to blockchain technology is its security. Because of the cryptographic hashing used and the fact that there is no single-point-of-failure in the chain as everyone has a copy of the blockchain, then it is inherently more secure against hackers, In recent years hackers have managed to infiltrate various financial institutions and companies which hold all their data in centralised databases, stealing passwords and confidential information about users (Swan 2017). This undermines public trust in such institutions and in their ability to maintain effective confidentiality. By replacing this ‘trust’ with cryptography, blockchain is virtually impossible to tamper with.

Increased digitalisation of transactions and access to services such as banking, government and healthcare services has created increasing needs to verify users’ identities and allow them access into a network, whilst keeping out ‘undesirables’ such as hackers or persons seeking to commit fraud (Wolfond 2017). To enable more organisations to respond to consumers' desires to provide more digitally accessed services, it is necessary to ensure that digital identity can be robustly verified without the traditional reliance on paper-based documents such as passports or birth certificates or relying on users to remember multiple user names and passwords for every service they wish to access. These traditional systems are expensive to maintain and are relatively easy to abuse by creating forged documentation or data mining.

Currently, many service providers use identity management systems run through a centralised broker architecture to verify and authenticate the identity of a user. However, this relies on a single point of trust which is quite a weak system from a security standpoint as it can fail and can be tracked (and hence tampered with) quite easily (Wolfond 2017). Instead, having the ability to verify a user's identity through a decentralised blockchain-based model omits the need for a single intermediary and can allow for users' identities to be cryptographically protected to a much higher level than standard passwords and Personal Identification Numbers (PINs) do currently.

The potential cost savings associated with more secure, single-point user authentication alone are substantial. Martin (2016, cited in Wolfond 2017) estimated that it cost $31 (Canadian dollars) to manage lost, forgotten or stolen passwords per transaction. Wolfrond (2017) extrapolated that cost, assuming one lost, forgotten or stolen password incident per working Canadian per year, could result in a saving of $572 million (Canadian dollars) annually. Clearly, this money could be spent elsewhere providing greater value and reducing the need for offices and staffing in all aspects of identity verification and authentication, again saving significant sums of money annually for many businesses.

For the user, a decentralised blockchain network will allow him/her to access services much more quickly, however this will rely on the network and collaboration across multiple actors in the system to work. If organisations work together to agree how user identity can be verified, then it is a 'win-win' for both the organisations providing the service and users who want the convenience to access services at minimal cost and effort to them. It would not be in an organisation's best interests to devise their own unique ways of verifying users since that would require users to use multiple access models, which they do currently and which can be a source of considerable frustration to users (Wolfond 2017). It is far more efficient for all organisations to agree user authentication collaboratively, through an 'eco-system for digital identity' to provide a better user service.

Another interesting potential with blockchain will be the ability to pre-program transactions to 'self-execute' in accordance with an agreed contract, called smart contracts (Swan 2017). Whilst there are numerous examples of automated transactions currently in use such as direct debits and standing orders, blockchain smart contracts could have the rules and code written into them at the point of writing the contract, reducing the need for future interventions and reducing counterparty risk (ICAEW 2017).

4.5.3 What are the potential challenges to the development of blockchain?

Despite the clear benefits of blockchain, there are still a number of barriers to be overcome before it becomes widely adopted beyond the current niche of cryptocurrencies. The underlying transaction processing of blockchain for the cryptocurrencies is for data miners (who validate and post transactions) to be rewarded with a fee (usually new bitcoins), so there would need to be agreement on the reward for miners to validate many more transactions than are currently undertaken (ICAEW 2017).

A substantial growth in blockchain transactions would also cause issues for the timing and computing capacity of any network. It requires substantial computing power to validate and verify transactions using blockchain technology (ICAEW 2017). Currently, only approximately seven small transactions or three average-sized transactions can be carried out per second: Visa in comparison, carry out tens of thousands of banking transactions per second (ICAEW 2017).

Another concern is the potential need to encrypt data where the contents of the blockchain are confidential, since all participants in the blockchain have access to everything, which for some applications may not be appropriate. Equally, there is an issue of agreeing protocols between companies who may be competitors sharing a blockchain (ICAEW 2017).

For these reasons, it is unlikely that blockchain will have a sudden impact on the accounting profession; it is likely to be more of a gradual development over the next five years, once these issues are increasingly solved.

4.5.4 Implications of blockchain for accountants

The most significant effect of blockchain for accounting will be to eliminate the very basic data inputting and transaction processing work associated with bookkeeping. With smart contracts able to execute transactions embedded in the blockchain, the financial ledgers will require very little day-to-day interaction (Peze 2017). It will also mean that auditors will have access to the whole transaction records and the likelihood of errors and misclassifications should fall (LaFollette quoted in Hood 2018), reducing the need for complicated sampling, testing and verifying.

Hence accountants and auditors (both internal and external) alike need to be well trained on the technology in order to be able to deliver value to their organisations and to continue to improve the operations of the organisation (Rooney, Aiken, and

Rooney 2017). Currently, auditors' first point of departure in an internal audit is to review the ledger as maintained by the organisation and verify the transactions within it, including reconciling balances with external parties, such as customers, suppliers and banks. However, with blockchain technology, if there is one single record held and agreed already between the organisation and its partners, then there is no requirement to do this. This means that what internal auditors will need to do instead is ensure that the governance of the blockchains to which the organisation has access (and there could be several since it could interact with government and a myriad of other organisations) comply with the appropriately governance requirements of their own organisation – this will require collaborative working with other auditors in these other organisations (Rooney, Aiken, and Rooney 2017). Equally, accountants and internal auditors will need to consider the implications of real-time data – since blockchains will simultaneously update once new transactions are entered into them and distributed – potentially eliminating the need for laborious month or year-end closure practices.

These changes will require auditors to have a good understanding of blockchain technology to be able to continue to provide assurance and value to their organisations (Hood 2018; ICAEW 2017). They should be involved in the creation of the blockchains within their organisation to ensure the governance, controls and risk management considerations are adequately addressed (Rooney, Aiken, and Rooney 2017). They should also leverage their knowledge of their organisation to consider the optimal benefits from adopting the technology, such as checking the validity of smart contracts at initial inception (Hood 2018).

Whilst audit will not disappear, it will need a new approach. For external auditors, this may mean more checking on the security of authentication keys and the more aggressive pursuit of fraud (Hood 2018), but it will also mean that they will need to add value to clients based on more of an advisory role than currently (Asgeirsson quoted in Hood 2017) and acting as a bridge between data technology specialists setting up the blockchains and the business world (ICAEW 2017).

Despite the fact that it may be some time before blockchain totally revolutionises accountancy and finance, it is undoubtedly a disruptive technology which has the power to change the practices and skillsets of future accountants. It is also quite high on the agenda of current professionals in the finance world. Wesley Bricker, the Chief Accountant of the Securities and Exchange Committee stated:

> *"it is important that those in the accounting profession invest the time to understand new trends and developments in technology and commerce to identify their potential effects on financial reporting to investors" (Bricker as reported in Cohn 2017).*

4.6 Conclusion: accounting and technology

Technology has changed our lives and mostly for the better. It continues to develop at an ever-increasing pace. As we have discussed in this chapter, this has brought us unprecedented levels of data which requires making sense of, issues of storage and completely new ways of working. This will impact many jobs in the future, not least that of accountants – therefore it is imperative that accountants build on their analytical skills and inquiring nature to challenge and help develop the application of the technology to the business world in a sensible and ethical way. It will necessitate additional technical skills, but also communication and collaborative-working on the part of the accountant to build and maintain bridges between the technology and data specialists on the one hand and the business world on the other.

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