Exploring the use of big data analytics by management accountants in decision-making

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ABSTRACT

Title: Exploring the use of big data analytics by management accountants in decision-making

Keywords: big data, big data analytics, disruptive technologies, management accountant, management accounting change

The global business environment is constantly changing due to the advancement in technology. Currently, business organisations are experiencing a shift in their competitive strategy, operational structure and production methods due to the advancement in technology such as robotic processing systems, blockchain, artificial intelligence (AI) and the associated big data phenomenon. The shift in the business environment creates a change in informational demand by managers, which consequentially changes the management accounting practice in an organisation over time.

Big data, AI and robotics processing systems have gained acceptance as part of the fourth industrial revolution (4IR). This phenomenon is associated with the term 'disruptive technologies', meaning that the way we do things is bound to change, and the management accounting practice is no exception. The arrival of big data has created new big data technologies which assist in collecting and analysing big data for decision-making. The practice of management accountancy is to collect, analyse and communicate information for decision-making. This creates a linkage between the practice of management accounting and the function fulfilled by the big data technologies. Entities that will adopt big data technologies will have a competitive advantage to those that will not.

Management accountants should adopt new big data technologies in order to aid management in decision-making, as well as in creating a competitive advantage for the organisations they work for. This study explored the use of big data analytics by management accountants in decision-making. In doing so, the study assessed how management accountants practically interact with the real world of big data. Thus, within its context and from the participant's standpoint, Action Design Research (ADR) as a research approach was followed.

ADR is a research method that seeks a solution to prescribe, invent, build or evaluate and improve an artefact through a combination of the researcher's theory and stakeholders' ongoing practical use of the artefact in an organisational setting. As this was an exploratory study, the focus was on the diagnosis stage of the ADR process, where management accountants conceptualise the problem as a solution to the research objective. An induction approach was used to solve the

research question and as a result, the research was nested in an interpretivist philosophy, through the application of a qualitative research process. The institutional framework for management accounting change was applied as the foundational framework for the research study.

The study concluded that big data analytics, if used by management accountants, assist management in decision-making in a big data-driven business environment. It assists organisations in gaining competitive advantage. It was also found that a big data-driven management accountancy technology should be cloud-based, of a dashboard format, with the ability to handle large data sets and a capability to collect both internal (from the ledger) and external data from which, if a query is run, it is able to produce a robust report that can be exported into other formats. Further, management accountants need to develop big data skills to fully utilise the big data technology capabilities.

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CHAPTER 1

1 INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Background

Trends in the business environment, including technological advancement, can lead to a change in corporate strategy (Bhimani, 2015:8; Oesterreich *et al*., 2019:2; Rachinger *et al*., 2019:1144), thereby creating a change in informational demand by managers (Bhimani & Willcocks, 2014:476; Zainuddin & Sulaimana, 2016:468). This new informational demand consequentially changes the management accounting role and practices in an organisation (Bhimani, 2015:7; Bhimani & Willcocks, 2014:480; Oesterreich *et al*., 2019:7; Zainuddin & Sulaimana, 2016:468). Changes in the business environment are therefore one of the major determinants of change in management accounting practice over time (Talha *et al*., 2010:93; Zainuddin & Sulaimana, 2016:469). Kaplan (1984:390) depicts this concept in his call for a re-examination of management accounting practices during the 1980s. This call by Kaplan was prompted because of a change in the business environment caused by advancement in production technology and a shift in competitive forces, against a static management accounting practice (Johnson & Kaplan, 1987:24; Kaplan, 1984:390; Talha *et al*., 2010:83; Zainuddin & Sulaimana, 2016:466).

The global business environment is experiencing a shift in its competitive strategy, operational structure and production methods due to advancement in technology, which includes the use of robotics, blockchain and artificial intelligence (AI) (Gartner & Hiebl, 2018:1; Oesterreich *et al*., 2019:7; Rachinger *et al*., 2019:1150; Schwab, 2015:2), as well as the associated big data phenomenon (Raguseo, 2018:2). This creates an altered informational need by organisations, which consequentially creates a need for a change in the management accounting practice (Bhimani, 2015:7; Oesterreich *et al*., 2019:7; Talha *et al*., 2010:93; Zainuddin & Sulaimana, 2016:468).

1.2 Management accounting and financial accounting defined

Management accounting is the sourcing, analysis, communication and use of decision-relevant, financial and non-financial information to generate and preserve value for organisations (CIMA, 2018:3). The major distinction between management accounting and financial accounting is that management accounting is about practices that an organisation adopts to provide information to people within the organisation to aid decision making. Financial accounting, on the other hand, is concerned with the provision of information for external reporting purposes (Appelbaum *et al*.,

2017:30; Van der Stede, 2017:2). This research focuses on the management accounting aspects, as opposed to financial accounting.

1.3 Big data

Big data are datasets too large for processing through the traditional data-processing systems and therefore require new technologies for processing (Appelbaum *et al*., 2017:31; Janvrin & Watson, 2017:8; Power, 2014:223). It is data exceeding the organisational capability to store and analyse for accurate and timely decision-making (Phillips-Wren & Hoskisson, 2015:89; Raguseo, 2018:3). The main dimensions that assist in describing big data are high volume, high velocity, high variety and a complex veracity structure (Appelbaum *et al*., 2017:31; Grover *et al*., 2018:389; Inoubli e*t al*., 2018:1; Power, 2014:223; Raguseo, 2018:3). Big data is a product of digitisation of today's business and social environment (Gartner & Hiebl, 2018:3; Inoubli *et al*., 2018:1), and the linkages of machinery, computers, mobile phones and social media (Clayton & Clopton, 2019:1; Raguseo, 2018:3).

Besides computers and the internet of things (IoT), the development of automatic data collection techniques such as sensor networks, software logs, social media, cameras, radio frequency readers and global positioning systems (GPS) have contributed immensely to big data (Inoubli *et al*., 2018:1; Raguseo, 2018:3). Furthermore, big data is also created as new technologies to analyse such data are being developed (Gartner & Hiebl, 2018:3; Power, 2014:224; Raguseo, 2018:3).

Big data, AI and robotics processing systems (Oesterreich *et al.*, 2019:2) have gained acceptance as part of the fourth industrial revolution (4IR) (Schwab, 2015:1). This phenomenon is associated with the term disruptive technologies (Rachinger *et al*., 2019:1145), meaning that the way we do things is bound to change (Walker, 2014:181). Management accounting is no exception (Oesterreich *et al*., 2019:7). Competitive advantage will now belong to companies able to harness big data for decision-making, relative to those who will not (Bhimani, 2015:9; Bhimani & Willcocks, 2014:476; Gartner & Hiebl, 2018:7; Grover *et al*., 2018:390; Raguseo, 2018:5).

The arrival of big data marks a paradigm shift in the business environment, the business competitive forces and the organisational structure. Informational needs of organisations have been, and will be, disrupted and changed (Bhimani, 2015:6; Zainuddin & Sulaimana, 2016:469). As a result, management accounting practice is expected to change to fulfil the changing informational needs. This is in line with historical patterns of management accounting practice of evolving whenever there is a significant change in the business environment (Rikhardsson & Yigitbasioglu, 2018:38; Talha et al., 2010:91; Zainuddin & Sulaimana, 2016:468).

1.4 Literature review

1.4.1 Impact of big data analytics on the role of the management accountant

Extant research on the topic under study is very rudimentary and mainly limited to literature reviews, especially since the topic is still relatively novel. A literature review on the use and impact of big data/big data analytics on the role of the management accountant includes the work of authors such as Appelbaum *et al*. (2017); Gartner and Hiebl (2018); Nelson (2018); Oesterreich *et al*. (2019); Rikhardsson and Yigitbasioglu (2018) and Wadan *et al*. (2019).

The literature study revealed that the use of big data and big data technologies will disrupt the accounting profession – i.e. management accounting, financial accounting and auditing (Rikhardsson & Yigitbasioglu, 2018:44). It was highlighted that certain management accounting techniques will become irrelevant (Oesterreich *et al*., 2019:11; Rikhardsson & Yigitbasioglu, 2018:44) as they will be replaced by big data technologies (Rikhardsson & Yigitbasioglu, 2018:46). New costing methods will be adopted to align with new cost structures in line with new production methods shaped by big data technologies (Gartner & Hiebl, 2018:11).

Big data technologies will also open access to internal and external data sources to management, thereby improving forecasting, budgeting and estimating of resource requirement without needing the detailed input of the management accountant (Grover *et al*., 2018:392; Rikhardsson & Yigitbasioglu, 2018:43). It is expected that decision-making will be based on patterns/trends over time. If management therefore notices a consistent pattern, the “why” part of the decision making becomes irrelevant, rendering the fundamental human wisdom role of the management accounting skill obsolete (Rikhardsson & Yigitbasioglu, 2018:45). As a result, the skill set of the management accountant will need to change (Gartner & Hiebl, 2018:11; Oesterreich *et al*., 2019:21; Rikhardsson & Yigitbasioglu, 2018:45). The automation of data analysis also creates a challenge for the management accountant in that top management may perform the data analysis themselves (Clayton & Clopton, 2019:2; Gartner & Hiebl, 2018:11), thereby reducing the need and role of the management accountant (Gartner & Hiebl, 2018:11).

Where management is challenged by a lack of information technology (IT) expertise, it may seek help from IT data scientists (Gartner & Hiebl, 2018:11). This creates a huge challenge for the management accountant, as the data and information analysis role may be moved from the management accountant to that of the IT department (Gartner & Hiebl, 2018:11). However, for decision-making purposes, only relevant information for the decision to be made is required (Gartner & Hiebl, 2018:11; Rikhardsson & Yigitbasioglu, 2018:46). This is a skill-set the IT experts might lack. Management accountants, having a clearer understanding of business requirements,

are better positioned to select data of high quality that is then analysed and used for decision-making (Rikhardsson & Yigitbasioglu, 2018:46). Management accountants already have business acumen, but could be lagging with regard to data handling expertise (Rikhardsson & Yigitbasioglu, 2018:46). This can create a circular reference between the skills of the management accountant and that of a data scientist (Nelson, 2018:175; Rikhardsson & Yigitbasioglu, 2018:43). It is for this reason that management accountants should develop big data skills to bridge this gap and avoid falling obsolete in the profession (Gartner & Hiebl, 2018:11; Grover *et al*., 2018:399; Nelson, 2018:172; Oesterreich *et al*., 2019:21).

Big data will create new business structures and production methods rendering approaches to apply the traditional management accounting techniques as obsolete. An opportunity for management accountants to develop new costing approaches that suit the new business structure is therefore created, which then allows avoiding the re-insurgence of the 1980s crisis. The latter will be elaborated in section 2.2.5.

1.5 Motivation of the study topic

The topic and the research focus area is still a new and an emerging theme, and therefore still at an infancy stage (Gartner & Hiebl, 2018:12). Prior research in the area is limited to theoretical reviews of the topic, as no evidence of an empirical study could be found. Gartner and Hiebl (2018:12) recommend answering the following questions for future research:

- *To "examine how various management accounting practices may change due to Big Data?"*, and
- "*a scientific perspective to understand how management accountants meet the increasing demands for IS knowledge in the era of Big Data*".

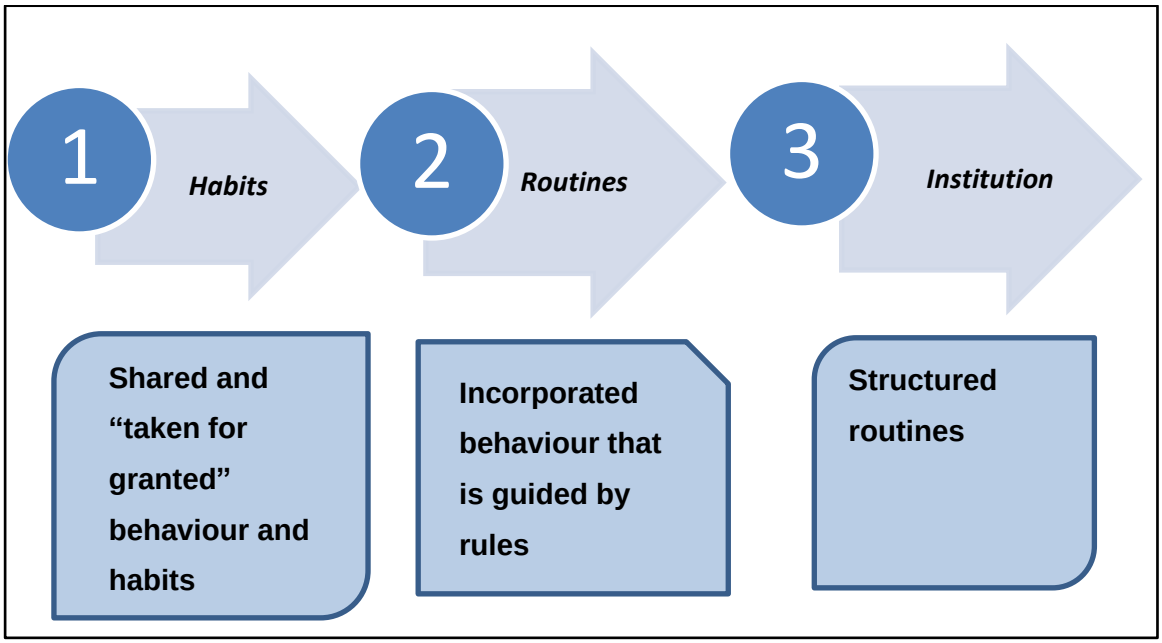
Rikhardsson and Yigitbasioglu (2018:46) also noted an empirical research gap to answer the following question: "how ready are management accountants to embrace such roles (big data roles), and what capabilities and skills are required to successfully fulfil these new roles?" Baker and Andrew (2019:1) call for research papers for a special issue of the journal Critical Perspectives on Accounting on "the use of Big Data and predictive algorithms in the work of management accountants". The aim of this study is therefore to define the gaps in the context of management accountants.

1.6 Theoretical framework

The institutional framework for management accounting change was conceptualised by Burns and Scapens (2000:4). The objective of the framework was to determine and understand the process through which management accounting practices change over time (Burns & Scapens, 2000:4; Johansson & Siverbo, 2009:147). Institution is defined as a social construct, originating from generally accepted beliefs and customs that a society assimilate, which develops into a fluid cog that then drives individual behaviour in the same social construct (Burns & Scapens, 2000:5). According to Aoki (2007:7), institutions are norms and shared values about how individuals in a society react and behave to different situations presented in their environment (Aoki, 2007:7). Burns and Scapens (2000:6) posit that an institution is created through habits, routines, rules and through a way of thought and action, habitually adopted by a group of people, which are repeated over time (Burns & Scapens, 2000:6). Routines are defined as how things are done, while rules are the ways things are done (Burns & Scapens, 2000:6; Johansson & Siverbo, 2009:147; Quinn, 2014:78).

According to Burns and Scapens (2000:11), management accounting as an institution within an institution remains stable or change over time due to the interactions of rules and routines (Johansson & Siverbo, 2009:147; Quinn, 2014:84; Ter Bogt & Scapens, 2018:11). Figure 1-1 below depicts the institutionalisation of "taken for granted" assumptions.

Figure 1-1: Institutionalisation of "taken for granted" assumptions

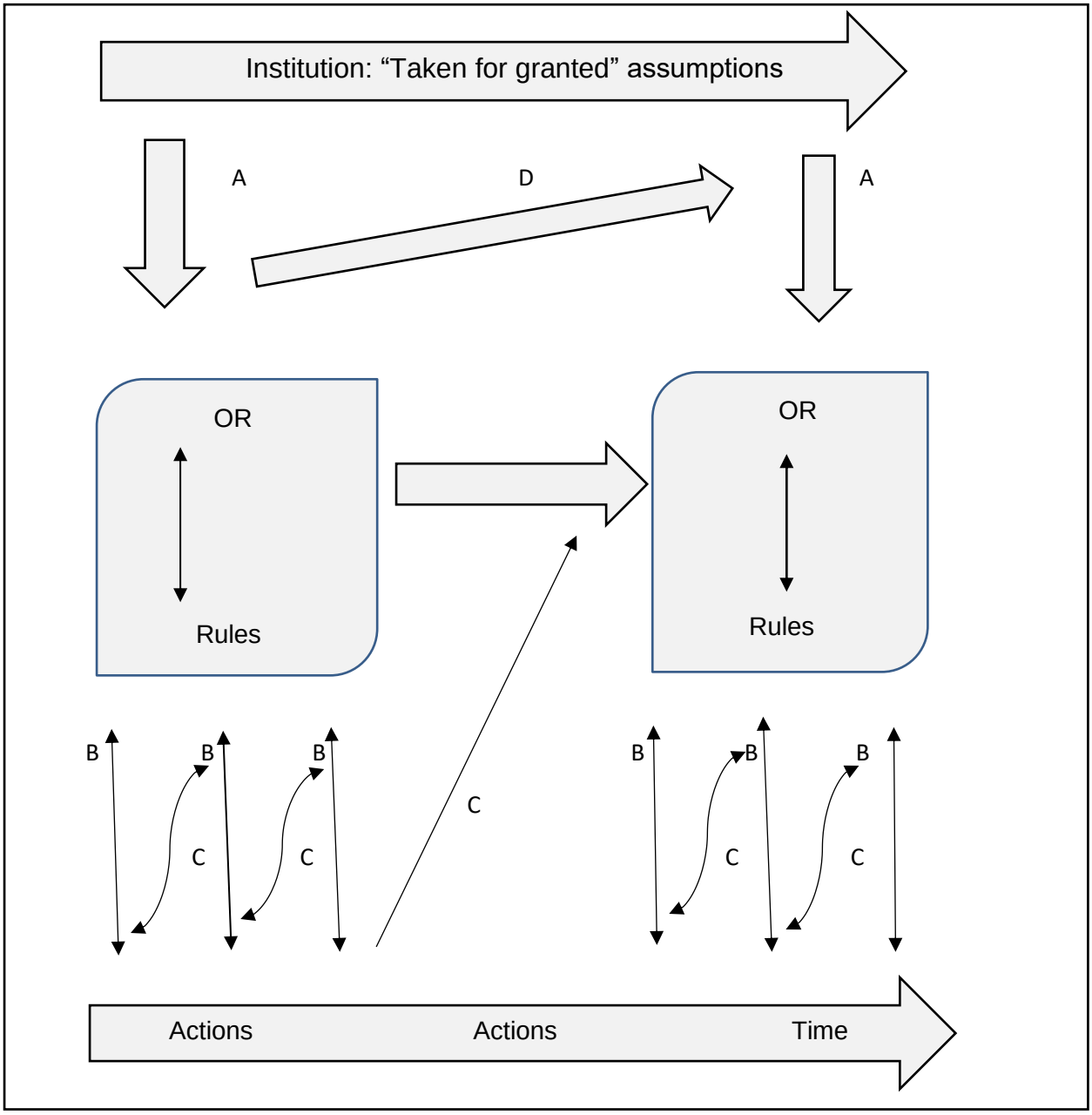


Source: Adapted from Guerreiro *et al*. (2006:199)

From Figure 1-1 it can be gathered that organisational "taken for granted" assumptions are encoded and enacted into rules through repetition of habits. With this repetition in performance, the habits are incorporated in behaviour and ultimately result in their institutionalisation (Guerreiro *et al*., 2006:199).

Figure 1-2 builds on this by depicting how management accounting practice changes, or remain stable, over time.

Figure 1-2: Institutional theory – stability and change of management accounting over time

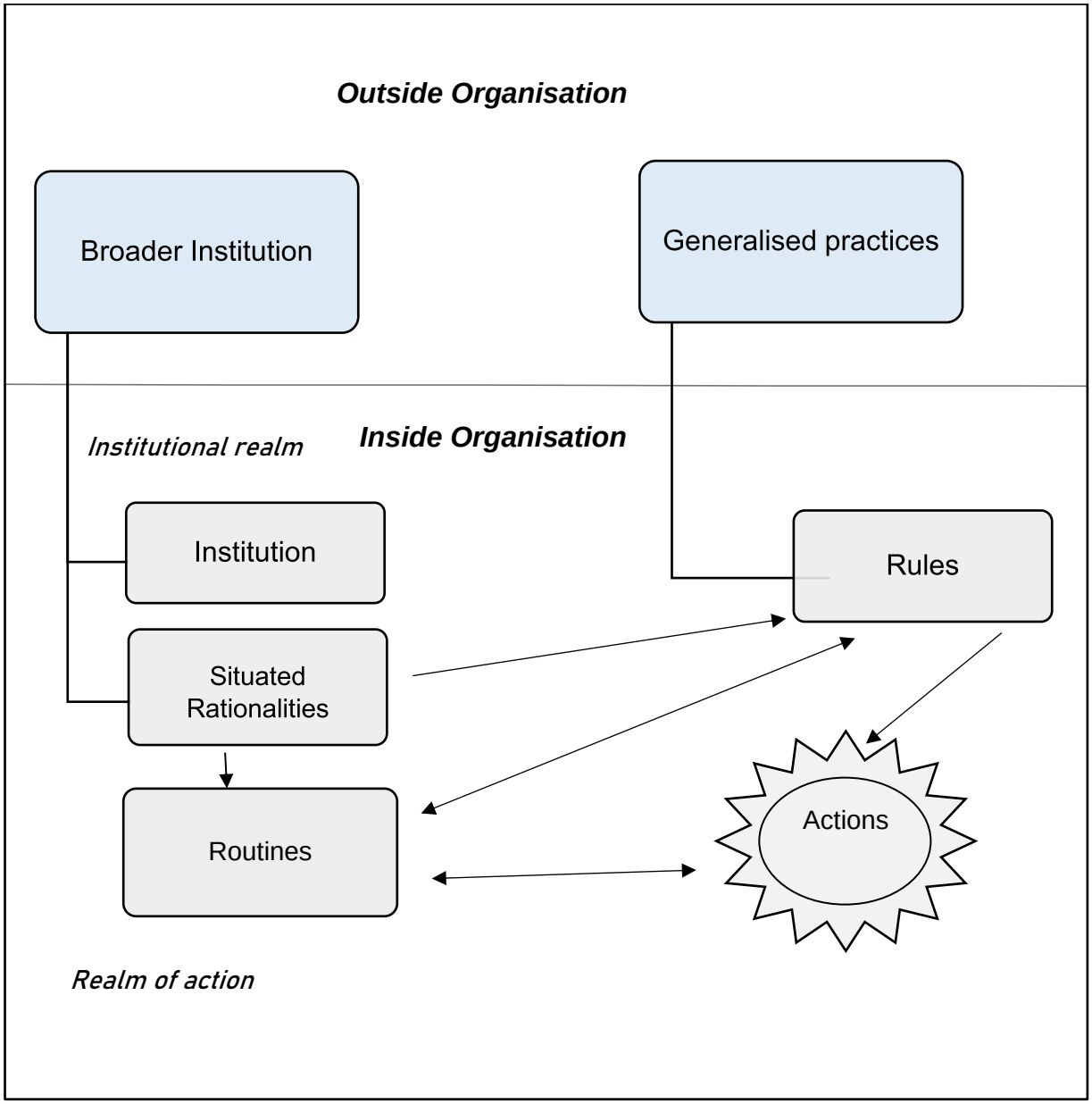


Source: Adapted from Quinn (2014:79)

The symbols in Figure 1-2 depict that institutional actions and “taken for granted” assumptions are encoded into rules (A) over time. This however requires a conscious choice and enacting of rules and routines (B). The C symbol represents the reproduction of rules and routines through repetition of behaviour, while symbol D highlights that a disassociation of rules and routines from historical behaviour ultimately results in becoming the way things are. From the above it can be gathered that the environment “forces” organisations to adapt and change their behaviour through new actions. Such behaviour is repeated and ultimately becomes the new way of doing things (Quinn, 2014:79).

The major weakness of Burns and Scapens’s (2000:4) theoretical framework is that it considers changes as determined by the *internal* actors, without consideration of the extent to which the external environment changes management accounting, i.e. situated actors (Burns & Scapens, 2000:10; Quinn, 2014:84; Ter Bogt & Scapens, 2018:3). Ter Bogt and Scapens (2018:3) therefore extended this framework to address this weakness. Since this research study considers a change in management accounting due to exogenous causes (Coccia, 2018:340) of institutional change – i.e. technological advancement – the institutional framework for management accounting change by Ter Bogt and Scapens (2018:13) is applicable as a foundational framework for this research study. This extended institutional framework is depicted below in Figure 1-3.

Figure 1-3: The institutional framework for management accounting change



Source: Ter Bogt and Scapens (2018:13), adapted

Figure 1-3 splits the institutional realm between inside the organisation and outside. It highlights that broader institutions and generalised practices do influence the organisation's rules, routines and ultimately its actions. This extended framework for management accounting change is founded on Burns and Scapens's (2000:9) theoretical framework incorporating, *inter alia*, the argument of Quinn (2014:84). The latter posits that *external* institutional pressures and changes may bring about management accounting changes within an organisation. The main premise of the extended framework is that "generalised practices which are underpinned by the broader institutions could be imposed on the organisation by powerful external actors, or taken up within

the organisation by groups who possess sufficient power to impose new rules" (Ter Bogt & Scapens, 2018:16).

Within the context of this study, the introduction of big data can be regarded as the external influence while the management's informational demand due to technological changes represent internal actors who possess sufficient power to impose new rules. It is therefore argued that consequently management accounting practice will change.

1.7 Problem statement

Management accounting practice has historically changed and evolved due to changes in management informational demand. These changes were caused by a shift in the business environment: globalisation, more focus on customers and rapid changes in technology. The arrival of the digital era and big data marks a new shift in the business environment where new technologies are disrupting the business structure. The role of the management accountant is poised to change as a result. Management accountants will have to develop a new and modern approach to handling, processing, analysing, interpreting and presenting such big data if they are to remain relevant in the provision of information to management for decision-making.

1.8 Objectives

The objectives of the study are broken down into the primary objective and secondary objectives.

1.8.1 Primary objective

The primary objective is to explore the use of big data and big data analytics by management accountants in management accounting practices and decision-making.

1.8.2 Secondary Objectives

The secondary objectives complement the primary objective of this research study. These objectives are as follows:

- To review the historical development of management accounting and the causal factors for its change over time (Chapter 2).
- To define big data and discuss whether and how it disrupts strategy, the organisational information need, and the role of the management accountant (Chapter 2).
- To discuss the philosophical underpinnings and formulate the research methodology adopted to achieve the set research objective (Chapter 3).

- To empirically explore the use of big data and big data analytics by management accountants in their practices, roles and decision-making (Chapter 4).

- To conclude and make appropriate recommendations on the research study conducted (Chapter 5).

1.9 Research design and methodology

Research methodology refers to the overall approach to the research and the theoretical framework underpinning the research process (Mackenzie & Knipe, 2006:5). This makes it easier for the reader to follow the research conducted (Khotari, 2004:25). This research comprises both a literature review and an empirical study. However, the philosophical underpinnings have to be discussed first.

A paradigm is a set of beliefs, values and assumptions that serve as a foundational basis for the strategy chosen by the researcher in conducting the research (De Villiers, 2015:28). A paradigm comprises ontological and epistemological assumptions.

1.9.1 Ontological assumptions

Ontology is the study of being (Scotland, 2012:9). It is concerned with the assumptions of the nature of the world and reality (Thornhill *et al.*, 2009:110; Scotland, 2012:9). The researcher views the world from either the realist perspective or the relativist perspective, with the realist perspective advocating that external reality is objective and exists objectively from the researcher (De Villiers, 2015:28). The relativist perspective, on the other hand, follows the thoughts that reality is subjective and depends on various circumstances and factors (De Villiers, 2015:31; Thornhill *et al.*, 2009:111). This research adopts the relativist perspective.

1.9.2 Epistemological assumptions

Epistemology is concerned with what constitutes acceptable knowledge in the field of study (Thornhill *et al.*, 2009:112), including what it means to know (Scotland, 2012:9). It is concerned with the assumptions the researcher makes on how knowledge can be created, acquired and communicated (Scotland, 2012:9).

The positivism epistemological assumption is that of the researcher being independent from the world – thus the researcher and what is being researched is independent (De Villiers, 2015:30). Positivism seeks the facts and causes of social phenomena apart from the subjective states of individuals. It is objective and encompasses deductive reasoning, using quantitative methods (De Villiers, 2015:30).

The epistemological position of interpretivism is one of subjectivism and is based on the assumption that the world does not exist freely from our knowledge thereof (De Villiers, 2015:31; Scotland, 2012:11). Knowledge is created through the interaction between human consciousness of the world, and thus through participation (Scotland, 2012:12). The interpretivist approach uses inductive reasoning and seeks to understand people, their actions and methods of reasoning, by following a qualitative research approach (De Villiers, 2015:32). This research is nested in interpretivism.

1.9.3 Research philosophy choice

In answering the research question posed in section 1.5, the researcher will seek to assess and understand the research phenomenon from an individual participant perspective. Specifically, the study will assess how management accountants practically interact with the real world of big data – thus within its context and from the participant's standpoint, (Mackenzie & Knipe, 2006:3; Scotland, 2012:12) of which the management accountant is the participant. This approach is based on the assumption that the world can only be understood from the individual participant's actions and views (Jamali, 2018:1; Mackenzie & Knipe, 2006:3; Scotland, 2012:12), in this case the management accountants' actions and views on the use of big data in their real work environment. These views will then be analysed to draw a pattern from which a meaning will be derived, thus creating knowledge. An inductive approach will be applicable to solve the research question (Jamali, 2018:1) resulting in this research nested in an interpretivist philosophy through the application of a qualitative research process.

1.10 Empirical study

The empirical portion of this study comprises the following methodological dimensions:

1.10.1 Action Design Research

Action Design Research (ADR) is a research method that seeks a solution to a practice-inspired problem through a combination of the researcher's theory, and industry practitioners' knowledge in an organisational setting (Sein *et al*., 2011:40).

Insofar as could be found, the topic under study is relatively novel, lacks empirical evidence and is currently limited to knowledge gained through a literature review. The literature study revealed that big data will disrupt the role and function of the accounting profession, including management accounting. However, no empirical evidence could be found of the use of big data and big data analytics by management accountants to enable the transition from the traditional management accounting practice to a big data driven practice.

This research seeks to empirically explore the above-mentioned problem. Mullarkey and Hevner (2019:9) identify a four-stage ADR process of developing and building a solution to the identified problem. These four stages include Diagnosis, Design, Implementation and Evaluation. Each stage allows an entry point into the process, by building on the prior intervention cycle (Mullarkey & Hevner, 2019:10). As this is an exploratory study, the focus will be on the diagnosis stage of the ADR process. The organisational stakeholders will interact at the first stage of an ADR process to conceptualise the problem and a solution as an artefact creation process (Haj-Bolouri *et al*., 2018:3). The first two principles of ADR aver that it is practice-inspired research while theory-ingrained (Sein *et al*., 2011:40). The problem has been inspired by practice and is ingrained in the institutional framework for management accounting change as extended by Ter Bogt and Scapens (2018:13). The ADR method is therefore suitable for this research.

Mullarkey and Hevner (2019:10) further explain that the diagnosis stage can include building critical success factors, problem definitions, requirements definitions, technical specifications and conceptualisations of a problem and solution. This study seeks to conceptualise the problem and explore a solution in an organisational setting.

1.10.2 Target population

Management accountants in South Africa are finance professionals represented by accountancy professional bodies such as the Chartered Institute of Management Accountants (CIMA), the Association of Chartered Certified Accountants (ACCA), the South African Institute of Chartered Accountants (SAICA), the South African Institute of Professional Accountants (SAIPA) and others. Additionally, some individuals do not belong to any professional body, but work as management accountants. Accessing all management accountant professionals in order to create a research population list is problematic, due to the difficulty in identifying, tracking and locating them. However, the researcher noted that the majority of CIMA members are management accountants or are in a role that involves management accounting practice.

CIMA is regarded as the prominent global professional management accounting body representing more than 150 000 qualified Chartered Management Accountants (CGMA, 2018:2) and has more than 229 000 qualified CGMA members and students in 176 countries (Robert Half, 2018:1). CIMA members mainly occupy the management accountant role or function in a corporate setting, while members of the other mentioned professional bodies are more inclined to the financial accounting role and even to external auditing in the case of SAICA members. A sample selected based on CIMA members is regarded as having a prominent representation of the management accountancy profession, which is the researcher's primary focus area. For

convenience purposes, the target population for this research is CIMA members and CIMA students working in practice in South Africa.

1.10.3 Sampling method

The objective of the research is to study a specific phenomenon that affects the role of the management accountant. As a result, a combination of purposive and snowball sampling approaches, i.e. non-probability sampling, will be applied in this research (Creswell, 2009:217; Johnson & Christensen, 2014:364; Palinkas *et al*., 2015:3). A purposive sampling approach selects specific individuals or cases that provide information needed to address the specific research problem (Johnson & Christensen, 2014:364; Palinkas *et al*., 2015:3). CIMA members and CIMA students working in practice are therefore a suitable population for this research due to their prominent representation of the management accounting profession.

Snowball or chain-referral sampling is applicable in circumstances where it is hard to construct a research population list, as well as reaching the population for the research purpose (Etikan *et al*., 2016:1; Heckathorn, 2011:1; Kirchherr & Charles, 2018:2). Since constructing a list of the population from which to select a research sample was noted as problematic, snowball sampling has then been identified as the most suitable sampling technique to apply instead. By applying purposive sampling, the first number of participants will be selected. The number of participants will then be expanded through the application of the snowball or referral- chain- technique where the first respondent recruits the next, and the wave continues (Etikan *et al*., 2016:1; Heckathorn, 2011:1; Kirchherr & Charles, 2018:4). A combination of these two sampling methods will be utilised until the point of saturation has been reached (Etikan *et al*., 2016:1; Heckathorn, 2011:1; Kirchherr & Charles, 2018:4).

1.10.4 Sample size

The universal population in this study are CIMA members and CIMA students in practice in South Africa. Five Associate Chartered Management Accountants (ACMA) / Chartered Global Management Accountants (CGMA) who confirmed their willingness to participate have been identified and will be selected as the initial sample. Thereafter, additional participants will be gathered through the application of the snowball principle, as described above.

1.10.5 Data collection method

Qualitative data will be collected through an online questionnaire, with the application of open-ended questions (Creswell, 2009:217). The questionnaire will be constructed based on the research objectives and extant literature to ensure the research problem is addressed.

Participants will be invited to complete the online questionnaire, which the researcher can then access for data analysis.

1.10.6 Data analysis

The qualitative data will be analysed through the establishment of data categories through the coding of the collected data (Khotari, 2004:122). A theme interprets a phenomenon by analysis of phrases and sentences to establish if they represent the essence and essentials of previous studies (Saldana, 2015:140). Thematic coding will be applied to identify a common understanding and perspectives to the research phenomenon presented to participants (Saldana, 2015:140). The responses will then be linked to research questions identified in the literature study to determine if they support, contradict or create new findings that prescribe a solution to the research objective.

1.11 Ethical considerations

Ethical adherence in research enables the achievement of the research objective through the promotion of values such as trust, respect, fairness and avoidance of harm. Such values result in the prohibition of fabrication and error in the research process, thereby promoting truth in the knowledge gained (Resnik, 2015:2). Throughout the research process, the researcher acknowledges the work and ideas of others. This research involves human participants in the research process. In order to mitigate the risk of personal harm during and as an outcome of the research study, participants will be fully informed about the nature and purpose of the research and will have to consent to taking part in the research. They will be clearly informed that participation is voluntary and that they have the right to withdraw at any stage. Research questions are designed with no participant deception motive. The research process embraces the anonymity and confidentiality of participants (Resnik, 2015:2).

As this research makes use of questionnaires, the anonymity and confidentiality requirement will be achieved through instructing participants not to put their names on the questionnaire. Further, participants will be given assurance that their responses will be kept confidential and that the data is collected only for the purposes of the research, and that it will not be made available to third parties. In the process of the data collection and analysis, the researcher avoids only collecting data that agrees with a preconceived result, but collects and analyses data with an open mind as supported by the entire data rather that what the researcher would like to see.

1.12 Overview

This study will comprise the following chapters:

Chapter 1: Introduction and background to the study

The introduction chapter introduces the study topic as well as the scope of the research. A background overview of the research issues is presented, including defining management accounting and how the arrival of big data may potentially reshape the management accounting profession. The chapter also introduces the problem statement and the research objectives, as well as a brief description of the research methodology and an overview of the study.

Chapter 2: Management accounting and big data

This literature review consists of a critical evaluation of the previous research and findings on the topic, with an objective of learning more about the topic as well as identifying research gaps. The chapter focuses on the role of management accounting, how it has evolved over time and the causes of its evolution in order to understand the causes as well as the probability of another change happening, should a similar condition occur. Big data is then defined, critically evaluated and followed by a discussion of how it is used by management accountants – with emphasis on the influence on the role and practices of management accountants.

Chapter 3: Research design and methodology

Chapter 3 defines research and describes the researcher's worldview and assumptions. In this chapter, qualitative research methodology is discussed.

Chapter 4: Results of empirical study

Chapter 4 describes the qualitative data collected, the coding of the data and a summary of the research findings. The results are all based on the qualitative questionnaires.

Chapter 5: Conclusions and recommendations

This chapter revisits the objectives of the research and summarises the work done towards achieving the research objective. A conclusion is then drawn based on data analysis conducted in Chapter 4, bearing in mind the research objective. A recommendation for further research is then provided to mark the end of the research work and presenting opportunities for future research.

The next chapter will present the literature review on management accounting and big data.

CHAPTER 2

2 MANAGEMENT ACCOUNTING AND BIG DATA

2.1 Introduction

The objective of this chapter is to provide a literature study of the topic to separate the known from the unknown so that the research study area may be singled out. The chapter contributes to the research process by addressing the first two points of the secondary research objectives raised in section 1.8.2 of Chapter 1. The chapter is divided into two sections.

The first section (2.2) reviews the historical development of management accounting and the causal factors for its change over time. The literature review elucidates the elements that cause management accounting to change over time, viewed through the lens of the institutional framework of management accounting change. The findings will be useful in assessing if similar elements are currently present in the business environment, in order to determine if management accounting practice is presently undergoing a change transition.

The second section (2.3) seeks to explore big data, its meaning, how it is used by management accountants, and how it disrupts strategy and the role of the management accountant.

2.2 Management accounting change: A historical perspective

According to Kristandl *et al*. (2014:3), management accounting practice has always been influenced by technology and changes in the business environment. The three major drivers of management accounting change have been (Kaplan, 1984:22; Kristandl *et al*., 2014:5) the following: 1) improved production methods, 2) improved technology, and 3) increasing globalisation. Management accounting practices change due to continuous change in the business environment, such as advancement in technology and organisational restructuring (Alsharari *et al*., 2015:478). According to the extended institutional framework for management accounting change, external and internal institutional pressures within an organisation may alter the management accounting practice (Ter Bogt & Scapens, 2018:5). Further, generalised practices which are underpinned by the broader institutions could be imposed on the organisation by powerful external actors. Alternatively, generalised practices may be taken up within an organisation by groups who possess sufficient power to impose new rules, resulting in a change in management accounting practice (Ter Bogt & Scapens, 2018:16). The section that follows explores the background of management accounting and the factors that led to its development and evolution over time, through the lens of Burn and Scapens's (2000) institutional framework for management accounting change, as expanded by Ter Bogt and Scapens (2018:5).

2.2.1 History of accounting and management accounting

Carbon dating the development of accounting science has been a problematic issue for accounting historians. What is, however, possible is to identify the application of particular accounting practices in certain places at a particular point in time. While Luca Pacioli is widely recognised as the father of the modern double bookkeeping system (Giroux, 2017:28), accounting history is rooted in the ancient times of before Christ (BC) (Collier, 2003:5). Accounting records were found in 3500 BC in Mesopotamia (Giroux, 2017:17), and in 3600 BC in ancient Egypt's central finance department of the Pharaoh (Collier, 2003:5). In Egypt, the scribes prepared records of receipts and disbursement of silver, corn and other commodities (Collier, 2003:5).

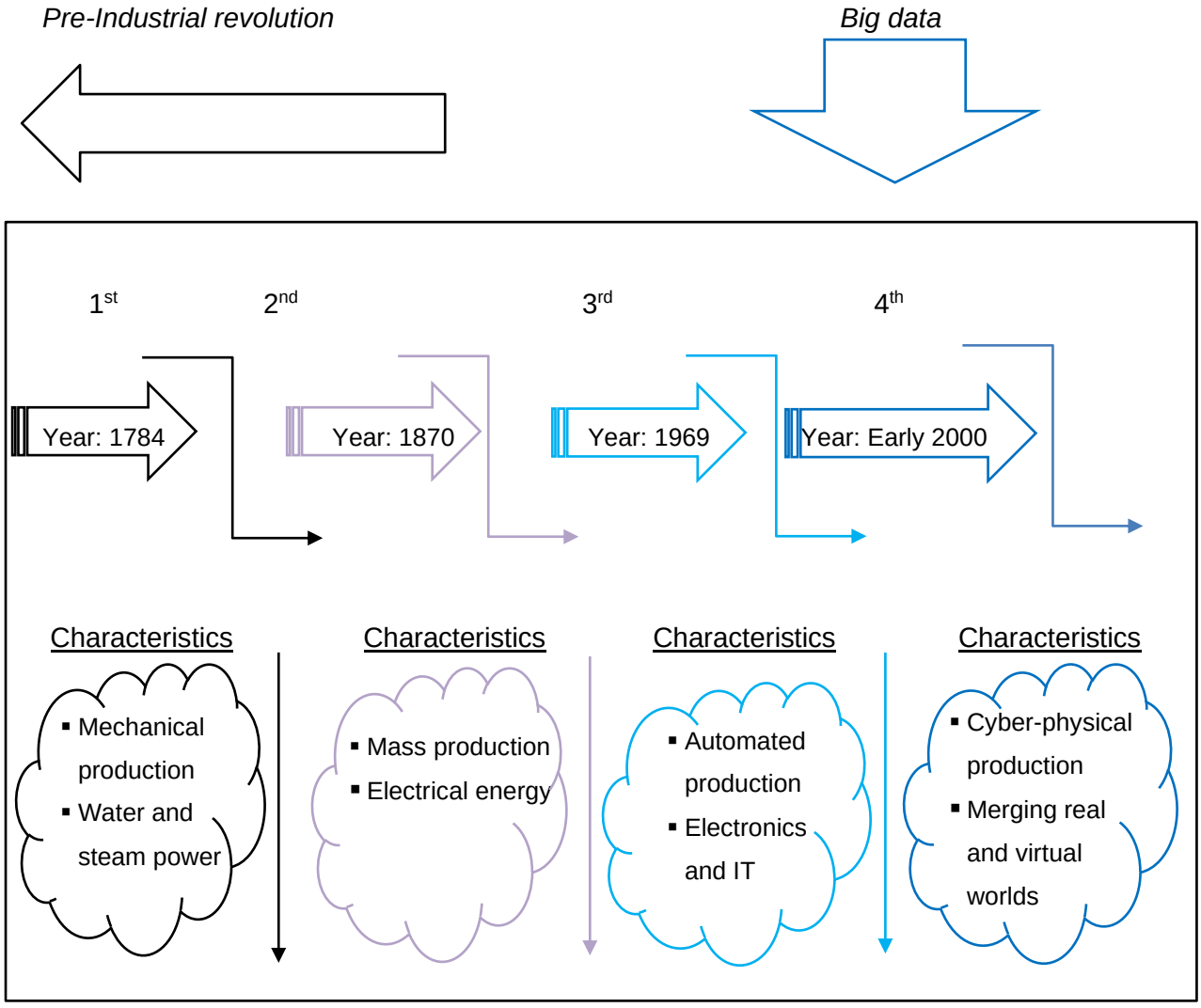
Modern-day bookkeeping is argued to have already been in existence in the fourteenth century in the Italian cities of Florence, Geneva and Venice, before the book of Pacioli was published (Collier, 2003:5; Williams, 1978:29). Besides, Williams (1978:29) asserts that Pacioli in his 1494 writing explicitly denied any responsibility for the origin of double-entry bookkeeping, but argued that he was merely writing down the systems which had been in existence for roughly two years in Venice (Williams, 1978:29). Pacioli therefore unified that which was an existing practice during the time, and popularised the bookkeeping concept through his book, the *Summa de Arithmetica, Geometria, Proportioni et Proportionalita of 1494* (Williams,1978:30).

Management accountancy emerged as a recognised branch of the accounting science, with a focus on making the best use of the available resources (Shotter, 1999:216). Robert Kaplan (1984:391) asserts that management accounting developed as an accounting discipline during the first industrial revolution. In the United States (US), cost accounting developed to provide cost and management control information to support the growth of large production and transportation enterprises during the 1850 and 1925 industrial revolutions (Johnson & Kaplan, 1987:24; Kaplan, 1984:393; Waweru, 2010:166). The European perspective saw cost accounting evolve in tandem to the US developments; however, its main conceptualisation in Europe was due to the development of large textile mills, such as Lyman Mills, during the mid-1850s (Kaplan, 1984:392).

While Kaplan (1984:391) credits the development of management accounting to the industrial revolution and the scientific management movement of the 19th century, the writings of Edwards *et al.* (1990:61) contrarily point out that management accounting already existed before the industrial revolution. Edwards *et al*. (1990:62) evidenced that the majority of the 19th century cost accounting concepts were already in use in certain parts of Europe by the 16th century. Therefore, the 19th century was not the period in which management accounting was conceptualised, but rather a period that saw significant advancement from a classical approach to an advanced level, due to the effect of the first industrial revolution. Through the lens of the expanded theoretical framework of management accounting change, management accounting appears to have

evolved from classical cost accounting to an advanced management accounting practice due to a change in the business environment resulting from improved production methods and an advancement in technology of the 19th century. Cost accounting practices before the industrial revolution are discussed in the section below. The following timeline in Figure 2.1 depicts the four revolutions, from the first industrial revolution to the fourth.

Figure 2-1: Industrial revolution timeline



Source: Author's illustration

From Figure 2.1 depicting the first industrial revolution up to the fourth industrial revolution, it can be seen that the characteristics evolved from the first industrial revolution until the fourth industrial revolution. The characteristics of the latter include cyber-physical production and the merging of real- and virtual worlds. Big data and big data analytics developed as part of the fourth industrial revolution.

2.2.2 Management accounting pre-industrial revolution

The following section presents the existence of management accounting practice before the first industrial revolution, and how management accounting practice changed due to the change in business environment as a result of the first industrial revolution. The section evidences that management accounting practice changes whenever there is a shift in the business environment – particularly when there is a change in technology.

In an evaluation and analysis of the accounting records of the Keswick Copper Mining Industry in England during the 16th century, Edwards *et al*. (1990:62) found evidence that sophisticated cost accounting systems were already in use at that time. Additionally, reports of the Staveley Coal mining operations of 1690 to 1783 provide evidence of the existence and use of departmental transfer pricing and the use of the cost per unit concept over this period (Edwards *et al*., 1995:31). The Carron Company, responsible for Scottish ironworks, used management accounting practices such as departmental cost management, budgeting and overhead allocation during the period 1759 and 1786 (Fleischman & Parker, 1990:214).

Forecasting and budgeting were noted to be also in use, as the records for the year 1615 of Keswick reflect an estimate of copper to be produced out of mining – a given quantity of copper ore (Edwards *et al*.,1990:68). An estimate of revenue and cost of production was then calculated, taking the following into account to produce the product of a shift (Edwards *et al*., 1990:71): 1) the cost of ore per shift, 2) labour, and 3) material. Other costs were then added as extraordinary charge (overheads) to arrive at production cost. The final cost was then benchmarked with the cost for other similar locations. Managers exhibited a cost consciousness by that time, including awareness of the fixed and variable cost concept (Edwards *et al.*,1990:67-71). Other notable locations include the Melincryddan Smellting, Neath, Great Britain – all in the UK – in the period 1779 to 1790 where the accountant distinguished fixed and variable cost in calculating costing for decision-making (Shotter, 1999:216).

The application of the principle of differential pricing in certain geographical areas of Europe was also recorded – a costing system that takes into account marginal costing concepts (Edwards *et al*., 1990:79). Walsh and Stewart (1993:785) evidence recordings of accounting for managerial control, and costing for pricing and information to control raw material flow during the period 1681 to 1703 at the New Mills Woollen Manufacturing.

From the Athena perspective in Greece, the socio-economic developments in the Golden Age of Greece (5th to 4th Century BC) resulted in a democratic government with political and economic justice that created a requirement for an accounting system (Costouros, 1977:2). Athena treasury

records of the period 454-407 BC show evidence of budgets that were used for planning and control. Such records showed financial plans in the form of a budget approved by the people, showing work to be done together with an estimate of revenue and expenditure needed, along with a comparison record of actual revenue collected against budget (Costouros, 1977:43). The use of forecasting, budgeting and comparison of 'budget' to 'actual' shows that cost and managerial accounting concepts were in use during the 5th century BC in Greece (Costouros, 1977:44). This is in contrast to Johnson and Kaplan's (1987:23) claim that the period before the first industrial revolution did not need any costing system, since the market provided all the information. Johnson and Kaplan also argue that there was no accountability concept since the owners ran the business process themselves.

This section evidenced that management accounting practices existed before the first industrial revolution. The management accounting practices performed were relevant to the business environment of the period. Due to technological advances of the first industrial revolution, management accounting practice then had to change. The change in management accounting practice during the first industrial revolution is discussed in section 2.2.3 below.

2.2.3 Management accounting during the first industrial revolution

Although Edwards *et al*. (1990:61) argue that cost accounting existed prior to the 19th century, the advancement thereof in the 19th century is widely recognised. This is as a result of the industrial revolution and an advancement in production methods as driven by the scientific management movement (Kaplan, 1984:393). Edwards *et al*. (1990:62) support this point, saying that the 19th century has more literature coverage of management accounting practice due to higher industrial activity during the 19th century, when compared to a period before. As a result, a lot of authors mainly wrote about management accounting practices that happened in the 19th century.

The first industrial revolution is hailed for the evolution of management accounting practices, because during this period there was a paradigm shift in the organisational scale, complexity and industrial activities. This resulted in the emergence of new and additional accounting procedures that included new methods in management accounting (Edwards *et al*., 1990:62). This line of thought is congruent with the institutional framework of management accounting change, which posits that management accounting practices alter due to a shift in the business environment. Advancement in technology may be recognised as the agent for management accounting change during this period. Chatfield (1971:12) previously elucidated this by asserting that management accounting transformed to an advanced level due to the metal industries, railways and chemical production industries in the US during the industrial revolution. The scientific movement's major players were engineers who developed standards through detailed analysis of time and material

required for an output. This resulted in a need to develop measuring units and performance against the developed standards (Kaplan, 1984:393). These technological developments then were the key agents for management accounting change, a phenomenon repeating itself in the current business environment due to the arrival of big data.

The industrial revolution brought with it an approach where an organisation internally performed the conversion of material, labour and knowhow into finished goods (Johnson & Kaplan, 1987:24; Kaplan, 1984:396). This resulted in a need to measure the output price of a product and the efficiency by which labour and material underwent the conversion process into finished goods (Johnson & Kaplan, 1987:24; Kaplan, 1984:392). With the advent of complex and competitive engineering firms, cost estimates were a requirement to bid on special contracts. Management accounting principles had to be applied in a suitable manner that provided advance information for such decision-making (Shotter, 1999:216). Management accounting therefore advanced in techniques to support such and the profit-seeking motive of the entrepreneurs with the main focus on the pre-determination of the product production cost, a price that was initially provided by the external market (Waweru, 2010:166). Given the current advancement in big data technology, new management accounting techniques are certain to develop.

2.2.4 Management accounting post the first industrial revolution

In applying the institutional framework for management accounting change, management accounting practice may be argued to have changed due to changes in organisational structure, as well as the imposition of management information required in a certain format by powerful actors – the organisation-distanced owners.

Management accounting concepts continued to evolve throughout the second industrial revolution, World War I and World War II period, and when the corporate legal persona was created (Marchant, 2013:2). Contributing to the development of management accounting change was also the economic depression of the 1870s. During this period, the manufacturing community sought to increase efficiency through improved management processes. As a result, more efficiency measurement tools were required, resulting in more advanced management accounting measurement tools such as return on investment (ROI) (Shotter, 1999:223). Additionally, businesses were converted to corporate legal personas, with owners distancing themselves from the daily operations of the business. Such organisations thereby became non-owner managed with a need for internal business performance information (Shotter, 1999:222).

In the US, huge integrated firms such as General Electric and Du Pont were established (Kaplan, 1984:396; Marchant, 2013:2; Shotter, 1999:222). Performance measures such as ROI and

management control became prevalent to assure the performance of the diversified hierarchy organisational structure (Johnson & Kaplan, 1987:26; Marchant, 2013:2). Due to changes in the business structure and the aim of the scientific management movement objective of eliminating inefficiencies (Marchant, 2013:1), management accounting practices were further developed to provide information suitable to measure the scientific management performance metrics (Kaplan, 1984:393; Shotter, 1999:222), including providing performance feedback to the detached business owners. The changes in the corporate and business environment, as highlighted above, may be regarded as the causal factors for management accounting change during this period.

2.2.5 Management accounting and the third industrial revolution: an 80s crisis

The third industrial revolution emerged in the 1970s and was characterised by automated production and information technology development (Shotter, 1999:228). Due to the deregulation of markets and improved global transport and communication, businesses became very competitive (Shotter, 1999:228). As a result, companies were pressurised to satisfy new customer taste through improved product quality produced at an efficient cost (Johnson & Kaplan, 1984:25; Shotter, 1999:228). Advanced manufacturing technologies that were machine intensive were introduced (Johnson & Kaplan, 1987:25). The arrival of advanced production methods changed the manufacturing cost structure (Johnson & Kaplan, 1987:25; Shotter, 1999:228), which saw a decrease in direct labour and inventory cost and an increase in machine and data-processing costs (Shotter, 1999:228).

During the early 1980s there was a public outcry that management accounting has fallen short in fulfilling its main mandate of providing information for decision making (Johnson & Kaplan, 1987:24; Waweru, 2010:174). The main cause of the mismatch was due to the above-stated change in the business cost structure, while management accounting practice remained static at 1920 level. This resulted in a failure to report in a modern way that matches the changing business environment and production methods (Johnson & Kaplan, 1987:24; Waweru, 2010:174). The business environment changed due to increased global competition, diversified product and production technology, a fluctuating currency exchange and an increase in price and demand for raw material (Johnson & Kaplan, 1987:28). When viewed through the lens of the institutional framework for management accounting change, management accounting practice changed to cater for the competitive business environment, thereby forcing managers to embark on cost reduction, improving productivity, and trying to cost products accurately and timely (Johnson & Kaplan, 1987:28). Yet, the costing methods used were based on techniques designed before 1925, and therefore fell short in providing relevant information to management as they were no longer applicable in the changed business environment (Johnson & Kaplan, 1987:28; Waweru, 2010:174).

Additionally, costing systems developed in the 1920s were suitable for a labour-intensive organisation (Johnson & Kaplan, 1987:28) as it focused on inputs. However, due to a shift from labour-intensive to machine intensive production methods, labour cost became a less significant component of the total production cost (Cooper & Kaplan, 1988:96; Johnson & Kaplan, 1987:28). As a result, a costing method that focuses on labour cost became misleading to management (Johnson & Kaplan, 1987:28). New costing and measuring matrices were required for an organisation to cost a product and to measure entity performance in the new production structure (Cooper & Kaplan, 1988:97). Costing methods such as activity-based costing (ABC) and a performance measurement dashboard, called the balanced scorecard (BSC), together with a variety of strategic management accounting techniques were developed to realign management accounting to the new entity production methods (Cooper & Kaplan, 1988:98; Norton & Kaplan, 2005:71). Kaplan (1984) is credited for identifying a need for management accounting practice change during this period, as management accounting practice fell behind the development of technology in the provision of information for decision-making.

2.2.6 Management accounting in the fourth industrial revolution

The literature review above supports the extended institutional theoretical framework of management accounting change that alters management accounting practices due to a shift in the business environment, organisational context and advancement in technology (Alsharari *et al*., 2015:478; Ter Bogt & Scapens, 2018:5; Kristandl *et al*., 2014:5). The arrival of big data marks a new wave in the industrial revolution, and its arrival has already been accepted as the fourth industrial revolution (Schwab, 2015:1). Anorld (2018:338) noted that business intelligence will have a profound impact on the practice of management accounting. Given the historical adaptation of the management accounting profession to changes in the business environment, it is no exception that a major shift is expected in the practice of management accounting due to the big data effect (Kristandl *et al.*, 2014:5).

2.3 Big data: A new paradigm for management accountancy

This section discusses big data as a new phenomenon for management accountants. The section starts by defining big data, traces its historical development followed by a literature review of its impact on business strategy and the role of the management accountant.

2.3.1 Definition of big data

Big data are datasets too vast for processing through the traditional data-processing systems (Appelbaum *et al*., 2017:31; Janvrin & Watson, 2017:8; Raguseo, 2018:3; Power, 2014:223), with its sheer volume, veracity and speed exceeding the organisation capacity for storage, accuracy

analysis and expedited decision-making process (Phillips-Wren & Hoskisson, 2015:89; Raguseo, 2018:3). It is a phenomenon requiring new technologies to handle (Power, 2014:223). Big data is a product of computers and the internet of things (IoT) (Inoubli *et al*., 2018:1). It is created by the digitisation of today's business and social environment through the interconnection of machinery, computers, mobile phones and social media (Clayton & Clopton, 2019:1; Raguseo, 2018:8). The main dimensions of big data are high volume, high velocity, high variety and a complex veracity structure, often referred to as the 4Vs (Gartner & Hiebl, 2018:2; Power, 2014:223).

Volume refers to size, sheer quantity, mass and large magnitude of the data collected and stored (Gartner & Hiebl, 2018:2; Phillips-Wren & Hoskisson, 2015:89; Power, 2014:223). Velocity relates to the speed, virality, rapidity or swiftness of the data and its continuous generation, its transfer rate between source and destination (Gartner & Hiebl, 2018:2; Grover *et al*., 2018:389; Phillips-Wren & Hoskisson, 2015:90; Power, 2014:223) and the time window of translating it into an intelligent basis for making a decision (Charles & Gherman, 2013:1070). Variety, on the other hand, is the diversity of forms, assortment and arrays in which data comes in. This include pictures, videos, audio and text (Gartner & Hiebl, 2018:2; Grover *et al*., 2018:389; Power, 2014:223). It is a cocktail of structured and unstructured details, views, facts and particulars from a widespread source (Charles & Gherman, 2013:1070). Veracity is the quality and viscosity of the data, its accuracy, authenticity and precision (Gartner & Hiebl, 2018:2; Grover *et al*., 2018:389; Power, 2014:223). Data could be intrinsically inaccurate due to its nature of being a complete mess (unstructured) or becoming inaccurate through processing errors (Charles & Gherman, 2013:1070; Gartner & Hiebl, 2018:2).

Big data is large information inflow to an organisation, originating from both internal and external sources, which is not easy to process by humans for decision making. Such information requires new technology to analyse and discern meaning out of it.

2.3.2 Historical development of big data

Big data originates in the early 1800s, the population-recording "avalanche of numbers" era, necessitated by the urban migration of the population attracted by the growth in industrialisation (Ambrose, 2015:209). This period sparked an interest in statistics and is often referred to as the number-explosion period (Ambrose, 2015:209). Work-related data was collected and this formed a basis for statistical analysis to understand time taken to perform a task (Bumblauskas *et al*., 2017:704).

Historically, the amount of data produced was limited as it was performed manually (Duan & Xiong, 2015:2). The arrival of computers, however, enabled the collection of vast data

(Bumblauskas *et al*., 2017:705). The advent of Enterprise Resource Planning (ERP) systems and the internet in the 1990s made data instantaneously available in real-time in organisations across the world (Bumblauskas *et al*., 2017:705; Kitchens *et al*., 2018:541). The increase in the global deployment of the internet and the World Wide Web (www) in the early 2000s, and the later increasing use of cloud-based computing, created a massive amount of data leading to the present-day phenomenon referred to as big data (Bumblauskas *et al*., 2017:705).

Besides computers and IoT, the development of automatic data collection techniques such as sensor networks, software logs, social media, cameras, radio frequency readers and global positioning system (GPS) have contributed immensely to big data (Duan & Xiong, 2015:2; Raguseo, 2018:3). New technologies to analyse big data are also being developed (Gartner & Hiebl, 2018:3; Raguseo, 2018:3; Power, 2014:224).

2.3.3 Impact of big data on business strategy and management

Big data creates new informational insights in the business environment, thereby creating new challenges and opening new opportunities that force and motivate firms to reconsider their business models and strategy (Bhimani, 2015:8; Oesterreich *et al*., 2019:2; Rachinger *et al*., 2019:1144). The advent of big data technologies is re-shaping, transforming and revolutionising the business environment (Grover *et al*., 2018:390; Wamba *et al*., 2017:357). Big data creates a new form of competition among firms in terms of productivity, innovation and growth (Bhimani, 2015:7; Charles & Gherman, 2013:1071). Wamba *et al*. (2017:357) argue that an investment in IT technologies alone does not necessarily create a competitive advantage, but also the effective utilisation of such technologies. Therefore, only companies with the ability to harness big data for decision-making will have a competitive advantage to those not having it (Charles & Gherman 2013:1071). This study aims to explore how management accountants can harness big data for decision-making to achieve this competitive advantage.

According to Barney (1991:102), a firm gains sustainable competitive advantage when it implements a value-creating strategy not simultaneously implemented or duplicated by a competitor. Proponents of the resource-based view posit that a firm has a sustainable competitive advantage when it owns unique economic resources (Barney, 1991:102). A unique resource is defined by Guirguis (2020:58) as having value, rare and not easily imitated, and non-substitutable. Based on the resource-based view argument, firms that invest in – and effectively utilise – big data technology, create a unique resource and a capability that enables them to have a competitive advantage to outperform others (Sena *et al*., 2019:224; Wamba *et al*., 2017:357). The ability of a firm to use big data allows it to analyse and manage its strategy, to be proactive and forward-looking (Wamba *et al*., 2017:357). However, Clayton and Clopton (2019:1) claim that the

success of such a process could be hindered by the requirement for a costly investment in big data technology. Currently, there is no universal big data technology which management accountants can use for decision making, therefore this study seeks to explore the function and capabilities of an application that is suitable for use by management accountants. Such an investment costs a lot of money.

The success of big data technology application in a firm depends on the firm leaders' ability to see the potential of big data, their commitment and their practical ability to exploit it, and in particular, what a firm chooses to do with big data (Charles & Gherman, 2013:1071). If utilised effectively, big data allows managers to act on both structured and unstructured data, thereby altering the status quo of using only structured data as a basis for strategy and decision-making (Bhimani, 2015:3; Gartner & Hiebl, 2018:1). Non-utilisation of big data has an "adapt-or-die effect", thereby leaving the modern economic business with no other option but to embrace big data and the related smart technologies if it is to escape demise (Charles & Gherman 2013:1071).

From a marketing strategy perspective, big data may be utilised to understand consumer behaviour, to bolster service delivery, for product innovation, to increase sales growth and to improve customer relations (Gartner & Hiebl, 2018:1; Raguseo, 2018:3). Customers are very important in a profit-making business. They are the very reason to do business. In doing so, there is a need for a satisfactory provision of their needs (Ilieska, 2013:328). Customer satisfaction improves sales growth and, as a result, the profitability of a business (Ilieska, 2013:328). Big data analysis may be used throughout the customer lifecycle – from acquisition, retention and expansion, to understanding their needs. The results may then be used to boost sales (Ilieska, 2013:328). However, the use of big data technology allows a company to obtain scores of customer information which, when analysed, provide customer insights at a lower cost than the traditional market survey and analysis approach (Kitchens et al., 2018:546). The reduction in cost of customer acquisition and retentions due to use of data analytics further improves the profit amount of the business (Kitchens *et al*., 2018:546). Business entities may, as a result, adapt a customer-centric strategy rather than a product-centric approach (Kitchens *et al*., 2018:546).

According to Grover *et al*. (2018:392), big data is useful for defending competition by acting as a barrier to entry and for market enhancement. It can be used as a symbolic value for reputational management and works as a benchmark to assess business performance relative to competitors (Grover *et al*., 2018:392). It enhances accurate decision-making since it allows for an analysis to be done on an entire observation rather than a sample (Charles & Gherman, 2013:1071). However, the challenge with big data is how to know whether the information source of the customers, market, product and services to capture and analyse is accurate and reliable, or not (Charles & Gherman, 2013:1072). To avoid unreliable decisions, there is a need to consider the

wider context of the data before placing reliance on it (Charles & Gherman, 2013:1071). This study seeks to explore how management accountants may use big data for decision making.

2.3.4 Impact of big data on management accountants

According to Rikhardsson and Yigitbasioglu (2018:44), big data will disrupt the entire accounting profession, namely management accounting, financial accounting and auditing. Certain management accounting techniques will become irrelevant as they will be replaced by big data technologies (Rikhardsson & Yigitbasioglu, 2018:46; Oesterreich *et al*., 2019:11). Accounting tasks such as inventory valuation, depreciation calculation and asset valuation will be performed by big data technologies. New costing methods will be adopted to align with new cost structures in line with new production methods shaped by big data technologies (Gartner & Hiebl, 2018:11; Rikhardsson & Yigitbasioglu, 2018:46).

Big data technologies will open access to internal and external data sources to management, thereby improving forecasting, budgeting and estimating resource requirements (Grover *et al*., 2018:392; Rikhardsson & Yigitbasioglu, 2018:43). Employee behaviour will be controlled and evaluated through the use of real-time events such as customer voice patterns on sales calls to improve service delivery, or customer online search patterns and shopping behaviour to develop a customer product recommendation (Rikhardsson & Yigitbasioglu, 2018:43).

Decision making will be based on a pattern over time. If management notices a consistent pattern, the “why” part of the decision-making process becomes irrelevant, rendering the fundamental human wisdom role of the management accounting skill obsolete (Rikhardsson & Yigitbasioglu, 2018:45). As a result, the skill set of the management accountant is threatened and therefore needs to change (Gartner & Hiebl, 2018:11; Oesterreich *et al*., 2019:21; Rikhardsson & Yigitbasioglu, 2018:45). However, Gartner and Hiebl (2018:11) argue that where big data does not join all the dots, i.e. incomplete data, and where the validity of the data used in the analysis is in question, human wisdom is required to fill the gap – thus giving hope to the function of the management accountant. The automation of data analysis also creates a challenge to the management accountant in that top management may perform the data analysis themselves, thereby reducing the need and role of the management accountant (Clayton & Clopton, 2019:2; Gartner & Hiebl, 2018:11).

While there are now big data technologies that management may use to access and analyse data for decision making, management is confronted with a challenge of selecting relevant data from a pool of infinite data. The large size of data available for analysis results in an information overload. Other challenges for managers include ensuring data validity, completeness, correct

format and immediacy (Gartner & Hiebl, 2018:11). This creates a threat to the management of making a decision based on unripe data, resulting in wrong and impulsive decision making. Dealing with big data to overcome the above challenges could also be a hindrance to the management accountant's role in a big data environment due to their lack of IT skills in data analysis (Gartner & Hiebl, 2018:11). This then creates a huge challenge for the management accountant in the sense that the data and information analysis role may be moved from their hands to that of the IT department (Garner & Hiebl, 2018:11). Data scientists may then play a pivotal role in filling this gap through their capability and expertise in handling the high volumes of complex data (Gartner & Hiebl, 2018:11).

However, for decision-making purposes, a good decision is one based on relevant information for the decision to be made, a skill set the IT experts might lack (Gartner & Hiebl, 2018:11; Rikhardsson & Yigitbasioglu, 2018:46). Further, despite the need to collect only relevant information, there could be a challenge faced by the IT experts in interpreting the information to top management, a skill only the management accountant holds (Gartner & Hiebl, 2018:11).

Management accountants, through their better understanding of business requirements, are better positioned to select data of high quality that is then analysed and used for relevant decision-making (Rikhardsson & Yigitbasioglu, 2018:46). Management accountants already have business acumen, but could be lagging in the data handling expertise. This then creates a circular reference between the skills of the management accountant and that of a data scientist (Gartner & Hiebl, 2018). It is for this reason that management accountants should develop big data skills to bridge this gap and to avoid falling obsolete in the profession (Gartner & Hiebl, 2018).

Big data technology investments come with high investment costs that will create higher fixed costs compared to variable costs (Bhimani & Willcocks, 2014:446). Boundaries of what defines a product are expected to keep shifting in a big data-driven production firm, and therefore product costing using ABC and the volume-non-volume costing approach is expected to fall away (Bhimani & Willcocks, 2014:446). Therefore, an opportunity for the management accountant to develop new costing approaches that suit the new business structure is created to avoid the re-insurgence of the crisis of the 1980s (Gartner & Hiebl, 2018:11).

2.3.5 Big data analytics

The main objective of big data analytics is to effectively process and analyse information using big data technologies to develop knowledge in enhancing value (Clayton & Clopton, 2019:2). Data analytics answers a firm's strategic questions based on available business environment- and firm data (Clayton & Clopton, 2019:2). The analytic process entails accumulating data by an

organisation into data lakes, from where it is fished and analysed for decision-making purposes (Kitchens *et al*., 2018:546). Data may also be obtained from third-party data providers and public sources (Nelson, 2018:168). Data analytics seeks to answer questions such as what if this trend continues, what will happen next, i.e. the best option (Nelson, 2018:170).

The challenge with data analysis is that it requires human skills in data analytic software, statistical and financial modelling, strategic problem identification, critical thinking skills and an ability to effectively communicate results – a skill set not easily found in one employee (Phillips-Wren & Hoskisson, 2015:89; Wymbs, 2016:62). Since data predictive software uses sophisticated mathematical modelling and programming, one wonders how effective it is as an analytic model given the challenge that the majority of big data is in an unstructured format (Duan & Xiong, 2015:12). This is so because data needs to be transferred from unstructured format to a structured form, resulting in the risk of a loss of data value due to a lack of expertise in handling big data and expiry meaning as a result of delay in processing data (Duan & Xiong, 2015:12).

Analytics include statistical models and other empirical methods which, when applied, create scientific prediction (Phillips-Wren & Hoskisson, 2015:89). The process requires a physical IT infrastructure onsite or cloud-based software on which the actual data analytic process is then performed (Duan & Xiong, 2015:2). System infrastructure captures, stores, transfers and shares the data, while actual data analytics process encompasses data search, analysis and visualisation (Duan & Xiong, 2015:2).

Big data analytics is generally categorised into retrospective, predictive and prescriptive analytics (Phillips-Wren & Hoskisson, 2015:88; Power, 2014:225). Descriptive data analysis is an analysis of historic data to understand patterns to make inferences about the future (Power, 2014:225). It uses reports and dashboards to vividly explain a past phenomenon (Jeble *et al.,* 2017:39).

Predictive data analysis involves the use of data-simulation scenarios, decision trees and clustering to predict the future (Duan & Xiong, 2015:5; Nelson, 2018:170; Power, 2014:225). It helps in understanding the future in terms of what can happen (Jeble *et al*., 2017:39). Predictive analytics enables an accurate prediction and determines what course of action to be taken (Nelson, 2018:170). It makes use of statistical models such as regression analysis, decision trees, Bayesian statistics, clustering, expert rules and neural networks (Duan & Xiong, 2015:10; Nelson, 2018:170).

Prescriptive data analysis is an analysis of real-time data that may trigger events, thus recommending action (Power, 2014:225). It prescribes different possible outcomes from which the best option is then selected (Jeble a*t al*., 2017:39; Nelson, 2018:170). Prescriptive analytics

seek to predict what will happen and why it will happen, as well as to quantify the effect (Nelson, 2018:170). It applies techniques such as “what if” and simulation and a capacity to change the input parameters to determine the outcome (Jeble *et al*., 2017:39).

There are big data technologies and software developed to convert unstructured data to structured data (Duan & Xiong, 2015:2). In an analysis of big data application software, according to Patrizio (2018:1), data analytic requirements for each company is unique, even for companies in the same industry. Data analytic needs for each company will therefore vary (Patrizio, 2018:1). As a result, there exists no blanket packaged software to serve all potential customers across industry, only a base application and tools which are custom-modified for each company (Patrizio, 2018:1). Domo, Teradata database, Cloudera, SAA Visual Analytics, SAP Vera, Oracle Big Data Suite and Tableau are among the data analytic applications available in the cloud for companies to use (Patrizio, 2018:4). However, their robustness, agility, efficiency and usefulness for management accountancy remain a discovery to explore. From a management accounting perspective, it would be interesting to find out which data analytic applications do management accountants use in practice.

2.3.6 The use of big data and big data analytics by management accountants

Management accountants provide information to management for decision-making (Appelbaum *et al*., 2017:30; Van der Stede, 2017:2). The role of the management accountant includes planning, forecasting, budgeting, cost determination and control, performance evaluation, and the provision of information to management for decision support, amongst other functions (Oesterreich & Teuteberg, 2019; Wadan *et al*., 2019). Big data analytics is an analysis of data to aid decision-making (Wamba *et al*., 2017:358). The objective of big data analytics to aid management in decision-making, is similar to the objective of the management accountancy function, thereby creating a linkage and a need for the integration of the two (Nelson, 2018:179). The main functions of management accounting are explained below, together with how the functions link to big data analytics.

Forecasting

Big data analytics may be used by management accountants to predict risk events. Probability analysis may also be used to predict outcome (Nelson, 2018:180). Such a prediction can reveal a shortfall on which management can act in time, a shortfall which might have gone unnoticed if such predictions are not used. Alternatively, the prediction may expose an emerging opportunity that the firm could seize to maximize firm value (Nelson, 2018:180). Data analytics may also be used in forecasting cost, a key element used for pricing decision (Rikhardsson & Yigitbasioglu, 2018:44).

Profit-volume-analysis

Big data analytics, when combined with forecasting techniques as described above, can predict customer-buying behaviour. This can then translate in the prediction of sales on which a sensitivity analysis may be performed to see the effect of different sales volumes and prices on net profit (Nelson, 2018:180).

Performance measurement

Big data analytics may be used to provide knowledge to employees so that they can make the right decision about the next task to be done. In that way, it improves employee performance. Employees may also be monitored through the use of videos, number of emails sent and analysis of customer voice tone on recorded calls (Rikhardsson & Yigitbasioglu, 2018:45). Performance management may be improved by identifying revolutionary, non-financial performance metrics that improve financial performance (Appelbaum *et al*., 2017:30).

Reporting

The role of the management accountant includes conveying information and results to management for decision-making. The management accountant may use the capability of big data to convey information in a more understandable way such as using graphs, trends and in a visualisation form (Nelson, 2018:181). Big data analytics incorporates the analysis of both structured and unstructured data, internal and external, financial and non-financial, and as a result, it supports the use of the balanced scorecard reporting framework presented in a real-time form (Appelbaum *et al*., 2017:30).

Customer analysis

Analytics may be used to segment customers into various purchasing power and purchasing habit categories. Such information may be useful for product deployment and product pricing decision (Nelson, 2018:182).

Cost management

Management accountants may utilise prescriptive analytics in selecting suppliers of raw material, and/or to select the best raw material product at the lowest cost, thereby reducing the total prime cost of production (Appelbaum *et al*., 2017:30). Data analytics may find use in costing processes, equipment, construction, projects and products (Amani & Fadlalla, 2017:41). In equipment-costing, big data is useful in estimating equipment cost of production, equipment replacement costs, equipment inspection and repairs (Amani & Fadlalla, 2017:41). It may also be used in defining cost drivers in an ABC environment. Using big data analytics, management accountants

may be able to estimate a product's production cost, determine a product's life cycle and can also use it for cost control (Amani & Fadlalla, 2017:41).

As mentioned before, big data analytics requires an in-depth understanding of statistical analytical skills and IT skills (Nelson, 2018:181). To achieve big data analytics, management accountants need to develop skills such as data mining, programming, correlation and regression and time series analysis (Nelson, 2018:181). This research also seeks to determine what data skill sets do management accountants need to develop in order to effectively utilise the big data phenomenon in aiding decision-making for value creation in an organisation.

2.4 Summary

The objective of this chapter was to address the first secondary objective set in Chapter 1 (section 1.8.2), namely reviewing the historical development of management accounting and the causal factors for its change over time. The chapter critically explored the origin of management accounting and its course of change over time through the institutional framework of management accounting change. It was noted that management accounting practices were in existence before the first industrial revolution. However, it has evolved during the first industrial revolution throughout to the third industrial revolution due to changes in the business environment.

During the 19th century, management accounting changed as a result of the industrial revolution coupled with an advancement in production methods as driven by the scientific management movement (Kaplan, 1984:393). In applying the institutional framework for management accounting change, changes in technology may be regarded as the external factor that triggered change while the scientific management movement represented internal powerful forces inside the organisation requiring change.

Post the first industrial revolution, management accounting practice is argued to have changed due to changes in organisational structure. This resulted in the imposition of management information required in a certain format by powerful actors – the organisation-distanced owner. Such actors represent internal powerful forces requiring change as explained through the institutional framework for management accounting change.

The third industrial revolution emerged in the 1970s and was characterised by automated production and information technology development (Shotter, 1999:228). Due to the deregulation of markets and improved global transport and communication, businesses became very competitive (Shotter, 1999:228). According to the institutional framework for management accounting change, advancement in technology and the deregulation of markets represent an external trigger for change, while management need for prompt and accurate information

represented an internal trigger for change. The major elements of management accounting change over time are globalisation, organisational context and technology.

The arrival of big data and AI marks a new wave in the business environment. Organisations that are able to effectively utilise big data will have a competitive advantage above those that do not. Big data, and the related technologies, are recognised as part of the fourth industrial revolution and is expected to transform the business environment similar to what had happened during the first industrial revolution. Management accounting tends to change whenever there is a change in the business environment, therefore management accounting is expected to change due to the big data phenomenon. The business cost structure will change, and as a result, management accountants are expected to develop new costing and management accounting techniques that apply big data technologies.

The analysis of big data requires specific techniques and new technologies. Management accountants will, therefore, have to learn new skills related to business analytics and big data technology to effectively utilise the potential of big data. As mentioned already, organisations that will be able to utilise big data effectively, will have a competitive advantage to those that will not utilise it.

The next chapter will address the research philosophical underpinnings and design, and will formulate a research methodology to be adopted to address the third secondary research objective, as stated in Chapter 1 (Section 1.8.2).

CHAPTER 3

3 RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The purpose of this chapter is to discuss the research philosophical underpinnings, and to design and formulate a research methodology to be adopted to address the third secondary research objective, as stated in Chapter 1 (section 1.8.2). In structuring the research design, Chapter 1 introduced the research problem and research objectives (refer to sections 1.7 and 1.8). Ethical considerations were also addressed in Chapter 1 (section 1.11), while a literature review on the relevant topics followed in Chapter 2. The aim was to understand what is known about the topic under study and to identify the unknown so that it can be further researched.

This chapter discusses research philosophical underpinnings, research approach, the research design and methodology and the research method component of the research design. The chapter concludes by choosing qualitative research and applying action design research (ADR) as the research method suitable for this study. The sampling method adopted is explained, followed by the choice of the online questionnaire approach as the method suitable in this study. The chapter concludes by adopting a thematic analysis approach in analysing the collected data, as well as assessing the methodological rigour. The data analysis process is performed in the next chapter, Chapter 4. ADR is discussed in detail in section 3.6.1 below, followed by the data collection and analysis methods from which a conclusion is then drawn in Chapter 5.

3.2 Paradigm

A paradigm is a set of beliefs, values and assumptions that serve as a foundational basis for the strategy chosen by the researcher in conducting the research (De Villiers, 2015:28). It is the way the researcher views the world, with the researcher's perspective of the world influenced by the researcher's orientation to a school of thought. This research is nested in interpretivism. The epistemological position of interpretivism is one of subjectivism. Individual experiences in their real-world are constructed into meaning (Creswell, 2014:37). It is based on the assumption that the world does not exist freely from our knowledge of it (De Villiers, 2015:31; Scotland, 2012:11). Knowledge is created through the interaction between human consciousness and the world. That is through human participation, experiences and human views of their experiences (Creswell, 2014:37; Scotland, 2012:12). The interpretivist approach uses inductive reasoning and seeks to understand people, their actions and methods of reasoning. Data is collected in a wider context open-ended approach to understand a phenomenon, allowing room for participants' detailed

explanation of their experiences and beliefs. However, there is no need to prove an existing theory or law (De Villiers, 2015:32).

It is important to note that the researcher's background in an interpretivism philosophy influences how he/she interprets research findings, thereby ruling objectivism (Creswell, 2014:38). This research seeks to understand the big data phenomenon and how it affects the role of the management accountant from an organisational context, with no application of an experiment. This then makes interpretivism philosophy suitable for this research. A paradigm comprises ontological and epistemological assumptions (Creswell, 2014:35).

3.2.1 Ontological assumptions

Ontology was introduced in section 1.9.1 of Chapter 1. It is the study of being (Scotland, 2012:9). Ontology is concerned with the assumptions of the nature of the world and reality (Thornhill *et al.*, 2009:110; Scotland, 2012:9). The researcher views the world from either the realist perspective or the relativist perspective, with the realist perspective advocating that external reality is objective and exists objectively from the researcher (De Villiers, 2015:28). Objectivism separates the existence of social entities to the social actors that are connected with their existence (Thornhill *et al.*, 2009:110).

The relativist perspective, on the other hand, follows the thought that reality is subjective and depends on various circumstances and factors (De Villiers, 2015:31; Thornhill *et al.*, 2009:111). It follows the subjectivism assumption, which posits that social phenomena are created from the perceptions and actions of social actors concerned with the existence of the assumptions (De Villiers, 2015:32; Thornhill *et al.*, 2009:111).

According to Scotland (2012:12), a researcher has to take a side regarding how things are and how things work. This research seeks to explore how management accountants practically interact with and perceive the impact of big data in their practices in a real-world context, out of which knowledge will be created. This research thus adopts the relativist perspective.

3.2.2 Epistemological assumptions

Epistemology is concerned with what constitutes acceptable knowledge in the field of study (Thornhill *et al.*, 2009:112), including what it means to know (Scotland, 2012:9). It is concerned with the assumptions that the researcher makes on how knowledge can be created, acquired and communicated (Scotland, 2012:9). The epistemological assumptions may be broken down further into four subdivisions, namely that of positivism, realism, pragmatism and interpretivism (Thornhill

et al., 2009:119). These subdivisions form a continuous sequence that portrays slight similarity to the adjacent one, except for positivism and interpretivism which are distinct (De Villiers, 2015:29).

3.3 Approach

This research follows a qualitative approach. Qualitative research is a method that seeks to find a solution to a research problem through the collection of non-numeric data (Johnson & Christensen, 2014:82). It is exploratory and knowledge is generated from a groundwork perspective through the study of a phenomenon in its natural settings (Johnson & Christensen, 2014:84). Qualitative research uses an explanation of participants' experiences, beliefs and values to obtain an understanding of sophisticated processes, situations and reality (Creswell, 2014:32; Queiros *et al.*, 2017). Data is usually collected using interviews, participants' observations or open-ended questions (Johnson & Christensen, 2014:85). Since the data collected is in the form of words or verbal symbols, a descriptive approach such as patterns or themes are used to analyse the data from which the researcher interprets to discern knowhow (Creswell, 2014:32). An induction approach will be applicable to solve the research question (Jamali, 2018:1), resulting in this research nested in an interpretivist philosophy through the application of a qualitative research process.

3.4 Research design

The research design is a blueprint of the research process. It details the research structure, which then spells out how the process will achieve the research objective. It is a plan, a strategy followed to logically integrate the different components of the study as well as the resources required to perform the research. Included in the design are research constraints and ethical considerations in the research process (Khotari, 2004:31; Thornhill *et al.*, 2009:136).

3.5 Research design and methodology

Research design and methodology refer to the overall approach to the research and the theoretical framework underpinning the research process (Mackenzie & Knipe, 2006:5). This research comprises both a literature review and an empirical study. The literature review components were addressed in Chapter 2. This chapter addresses the empirical study approach; however, it commences by firstly discussing the philosophical underpinnings as detailed below.

3.6 Research methodology

Research methods are the techniques used in conducting research (Khotari, 2004:24). Mackenzie and Knipe (2006:7) explain them as procedures or tools used for collecting and analysing data. Tools that may be used in qualitative research include observation, focus groups

or interviews (Thornhill *et al.*, 2009:318; De Villiers, 2015:43). This research seeks to explore the impact of big data on the role and practice of management accountants. To achieve the objective, a detailed account of a management accountant's experience of the phenomenon in practice is required. This research then applies the questionnaire approach, because it allows the researcher to gain a detailed and deeper account of the context. The questionnaire approach is discussed in detail in section 3.6.3. Since the research objective is to find a solution from the participants' perspective within an organisational setting, the research problem will be diagnosed through the lens of ADR. ADR and its suitability for this research are discussed in detail below. Section 3.6.4 of this chapter details how the collected data will be analysed.

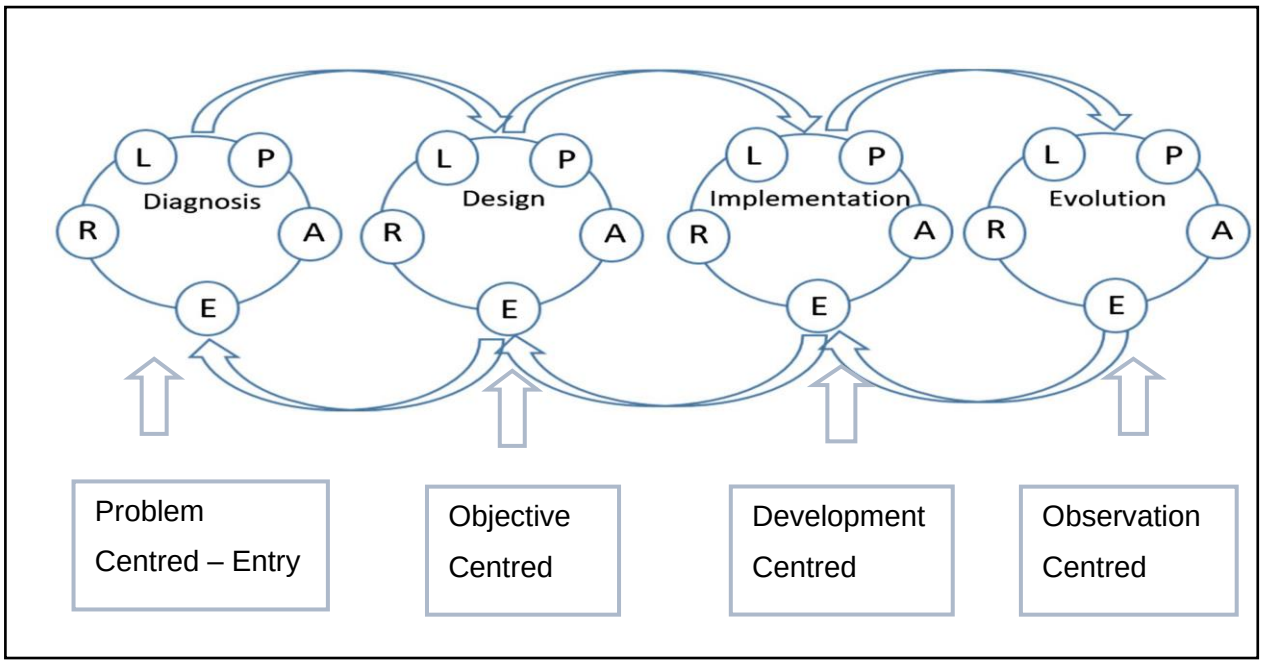
3.6.1 ADR

As described in chapter 1 (section 1.10.1, page 11), ADR is a research method that seeks a solution to a practical problem. One of the objectives of ADR is to solve a problem encountered in an organisation setting (Sein *et al*., 2011:40). The approach to a problem-solving challenge is addressed in the first stage of Sein's ADR model, referred to as the problem formulation stage. This stage is regarded as the research trigger, as it is at this stage that a problem is perceived. This results in a problem formulation process from which a research opportunity is conceptualised (Sein *et al*., 2011:40).

Mullarkey and Hevner (2019:8) advance the problem formulation stage by positing that it may be applied at a much earlier stage of the ADR as a means to identify the fundamental aspects and underlying factors of a research problem. According to Mullarkey and Hevner's (2019:8) four-stage ADR process, this stage is referred to as the diagnosis stage. The diagnosis stage may merely involve the conceptualisation of a problem (Mullarkey & Hevner, 2019:10). Depicted in Figure 3-1 is the four-stage ADR process by Mullarkey and Hevner (2019:8), which shows the Diagnosis, Design, Implementation and Evaluation stages. Each stage supports the iterations of the ADR intervention cycle of Problem formulation (P), Artefact creation (C), Evaluation (E), Reflection (R) and Formalisation of learning (L). According to Mullarkey and Hevner (2019:11), entry into the four-stage ADR process can occur at any point.

Figure 3-1 illustrates that the problem-centred entry point denotes a stage where the research problem is not yet well understood. The diagnosis stage is then adopted as an entry point to understand the research problem (Mullarkey & Hevner, 2019:15). As this research is an exploratory study of the big data phenomenon for management accountancy, the focus will be on the diagnosis stage of the ADR process. This stage is suitable because a problem is identified, but no detailed knowledge of the problem is yet available. The research seeks to address that gap.

Figure 3-1: The four-stage ADR process



Source: Mullarkey and Hevner (2019:9), adapted

Figure 3-1 depicts the four stages of an ADR process, where stage 1 is the diagnosis stage, stage 2 the design stage, stage 3 the implementation stage and stage 4 the evaluation stage. According to Sein *et al*. (2011:40), the problem formulation stage is guided by two principles. The first two principles of ADR posit that the problem should be practice-inspired but theory-ingrained (Sein *et al*., 2011:40).

Principle 1: Practice-inspired. This research identifies that a problem in the practice of management accounting exists due to the arrival of the big data phenomenon. The problem has been inspired by practice in the sense that big data has a direct impact on the actual practice of management accountancy. A literature review posits that the role and function of management accountancy will change due to the impact of big data.

Principle 2: Theory-ingrained. This research is ingrained in the institutional framework for management accounting change, as extended by Ter Bogt and Scapens (2018:13). The institutional framework for management accounting change seeks to understand the factors that result in management accounting practice to change or to remain stagnant over time. It posits that management accounting changes due to both internal and external forces that have the power to alter the management accounting practice. In this study, big data is accepted as an external force that has a potential to change the practices of management accountancy within

organisations, as management accountants and organisations respond to the impact of the big data phenomenon.

The study seeks to find a solution through the interaction of the researcher and management accountants that are in practice and experiencing the phenomenon in the real world. Interviews will be used to get into contact with participants.

3.6.2 Sampling and site selection

All items in the study field make up the study population or the universe (Johnson & Christensen, 2014:346; Khotari, 2004:14). The coverage of all items in a population is a census (Johnson & Christensen, 2014:343; Khotari, 2004:14). Covering the entire population is non-attainable in practice due to a limitation in resources available. In such a situation, a few items are selected that represent the total population (Khotari, 2004:14). The few items selected that are representative of the population are called a sample (Johnson & Christensen, 2014:345). The sample is usually selected using the random sampling method (Johnson & Christensen, 2014:347). The selection of a sample using the random sampling method is called probability sampling. In some other cases, non-random sampling may be applied (Johnson & Christensen, 2014:364). Random sampling contrasts non-random sampling in that it is a probability sampling technique that selects a sample that resembles the population from which it comes, while non-probability sampling does not (Johnson & Christensen, 2014:348).

Where there is a need for the identification and selection of information-rich cases, a different approach rather than random sampling is required to make use of limited resources in an effective manner that achieves the research objective (Johnson & Christensen, 2014:369; Palinkas *et al*., 2015:3). Such an approach requires identification and selection of knowledgeable individuals, experienced in the phenomenon being tested, available and willing to participate in communicating their experiences and opinion on the phenomenon (Palinkas *et al*., 2015:2). The objective of the approach is to locate participants that have specific characteristics that meet the characteristics of the population under study (Johnson & Christensen, 2014:370). In such a case, the researcher typically defines a set of criteria or attributes that the participants to be studied must possess, and then uses these criteria to distinguish the people of potential interest from those that should be excluded (Johnson & Christensen, 2014:370). Such an approach is called purposive sampling (Johnson & Christensen, 2014:369). Purposive sampling was chosen as the sampling method for this research study and is discussed in the section below.

In chapter 1 (sections 1.10.2 and 1.10.3) the target population, site selection and sample were described. It was highlighted that the target population for this research were CIMA members and CIMA students in practice in South Africa.

Sampling method

The objective of this research is to study big data as a specific phenomenon that affects the practice and the role of the management accountant. The phenomenon under study is specific, and as a result a combination of purposive and snowball sampling approaches, i.e. non-probability sampling, will be applied in this research (Creswell, 2009:217; Johnson & Christensen, 2014:364; Palinkas *et al*., 2015:3). A purposive sampling approach selects specific individuals or cases that provide the information needed to address the specific research problem (Johnson & Christensen, 2014:364; Palinkas *et al*., 2015:3). CIMA members and CIMA members in practice were therefore a suitable population for this research due to their prominent representation of the management accounting profession.

A combination of snowball or chain-referral sampling and purposive sampling was utilised to identify the first number of participants.

Sample size

The initial sample comprised five Associate Chartered Management Accountants (ACMA) / Chartered Global Management Accountants (CGMA) who confirmed their willingness to participate. Thereafter, additional participants were gathered through the application of the snowball principle as described in detail in chapter 1 (section 1.10.3).

3.6.3 Data collection method

Questionnaire

This research will collect data in a qualitative format using an electronic approach. In doing so, the qualitative data will be collected through an online questionnaire, with the application of open-ended questions (Creswell, 2009:217). The questionnaire was constructed based on the research objectives and extant literature to ensure the research problem is addressed. The research objectives and literature review were analysed into four main themes from which specific research questions were then developed. To collect the research data, participants were invited to complete the online questionnaire, which the researcher could then access for data analysis.

One of the drawbacks of the questionnaire method is that replies could be ambiguous, as the interviewer has no opportunity to clarify the question as is usually done in a face-to-face interview. This weakness was addressed through the construction of questions with clear vocabulary that

uses precise language with a clear definition of what the questions are referring to. Despite the weakness stated above, the method is cost-effective, free from interviewer bias, flexible for participants who are usually busy and allows participants to reflect on the questions before completing the questionnaire (Khotari, 2004:101). An online questionnaire has therefore been chosen as the most effective approach in this research.

3.6.4 Data analysis

Thematic analysis is one of the methods used in qualitative data analysis. It entails the identification of patterns (themes) for analysis (Braun & Clarke, 2006:79). It is descriptive in nature (Castleberry & Nolen, 2018:808). An item constitutes a theme if it contributes to answering the research question (Braun & Clarke, 2006:82). In this research, themes were developed based on the literature review and the research objectives. Research questions were then constructed from the research themes, followed by qualitative data collection.

The qualitative data will be analysed through the establishment of data categories through the coding of the collected data (Khotari, 2004:122). A theme interprets a phenomenon by the analysis of phrases and sentences to establish whether they represent the essence and essentials of previous studies (Braun & Clarke, 2006:79; Saldana, 2015:140). Thematic coding will be applied to identify a common understanding and perspectives to the research phenomenon presented to participants (Saldana, 2015:140). The response will then be linked to research questions identified in the literature study to determine if it supports, contradicts or creates new findings that prescribe a solution to the research objective.

3.6.5 Methodological rigour

Validity refers to the truthfulness of the inferences made from the research outcome (Johnson & Christensen, 2014:384). Reliability is grounded on the concept that, should the study be repeated, the same results would be obtained, thus being consistent (Johnson & Christensen, 2014:240). The concepts of validity and reliability are associated with quantitative research. In qualitative research, validity and reliability are replaced by the trustworthiness concept (Golafshani, 2003:604; Onwuegbuzie & Johnson, 2006:51). The trustworthiness concept comprises credibility, transferability, dependability and confirmability techniques. Credibility and transferability replace validity in qualitative research, while dependability replaces reliability. Objectivity is achieved through the confirmability technique (Hayashi *et al*., 2019:101).

Credibility. A persistent observation technique enhances the credibility, truthfulness and the believability of the results (Daniel, 2019:121; Forero *et al*., 2018:3; Golafshani, 2003:601; Onwuegbuzie & Johnson, 2006:51). It requires the identification of the main elements that are

relevant to the research problem and then persistently focuses on them in studying the phenomenon. To achieve this requirement, a literature review of the impact of big data on the role and practice of management accounting was performed, from which elements that have potential impact to the role and practice of management accountancy were identified. The elements were then categorised into themes from which research questions were developed. This ensured the development of research focus themes. The study was performed by focusing on the themes to meet the persistent observation technique.

Transferability. Thick description technique complements the transferability concept through a detailed collection of data about a phenomenon. Due to the detailed collection of data about a phenomenon, the findings of such a study are a true representative of the phenomenon and can therefore be transferable to other similar settings (Daniel, 2019:121; Forero *et al*., 2018:3).

To obtain detailed findings of the impact of big data on the role and practice of management accountancy, a purposeful sampling approach was used. Management accountants in practice were purposively selected as the universe population. The approach was followed to achieve the collection of data from participants who are experiencing the impact of big data in their role in practice and thus in context. Such participants have deep knowledge of the phenomenon under study and can contribute detailed information about the phenomenon. Purposeful sampling was used in conjunction with snowball sampling, until a point of saturation was reached to ensure adequate coverage of the sample size which enhances the quality of findings of the phenomenon. Further, open-ended questions were used to provide room and flexibility for participants to contribute as much detail about the phenomenon as possible.

Dependability. To comply with the Inquiry audit technique to establish the dependability of findings (Forero *et al.*, 2018:3), a second research supervisor was incorporated in the research process to provide an independent review, critique and challenge to the research design, methodology and the accuracy of the research findings.

Confirmability. This relates to the confidence that the findings of the research can be collaborated by other researchers (Forero *et al*., 2018:3). To achieve the above concept, a detailed audit trail of the research process has been maintained. This chapter (3) provides a detailed trail of the research design, paradigm, philosophical assumptions, methodology and data analysis techniques followed in this research. The trail provides clarity and a detailed record of the path and assumptions followed in this research to justify how the conclusion has been reached.

3.7 Summary

The purpose of this chapter was to discuss the research philosophical underpinnings and to design and formulate a research methodology to address the third secondary research objective.

The chapter described the research design, methodology and the research worldview assumptions used in this research. Qualitative and quantitative research as research methods were discussed, followed by the choice of using qualitative research as the method of research in this study. The qualitative research method was found to be suitable because this research seeks to assess and understand the research phenomenon from an individual participant perspective, thus within its context.

Since the phenomenon requires a solution from an organisational context with the involvement of participants directly affected by the phenomenon, this chapter then explored the use of ADR. ADR was described and evaluated. It was then chosen as a method applicable to this research. The method will be used in conjunction with the interview process.

The chapter also evaluated different types of interviews. The online interview process was then chosen as a method to be used in this research. To capture detailed experience of the participants of the phenomenon, the study applied an open-ended questionnaire approach. The chapter concluded by selecting thematic analysis as a method selected for use in the analysis of the data that was collected.

The data analysis process and description of findings are detailed in Chapter 4.

CHAPTER 4

4 RESULTS OF EMPIRICAL STUDY

4.1 Introduction

The aim of this chapter is to discuss and analyse the empirical study survey in order to achieve the third secondary objective stated in Chapter 1 (section 1.8.2). The stated objective is to empirically explore the use of big data and big data analytics by management accountants in their practices, roles and decision-making.

The chapter will start by explaining the data collection process, including the conversion of the questionnaire to an online survey tool and the tracking of the data collected. This is then followed by challenges and positives encountered in the data collection process. The next section (section 4.3) discusses the analysis of the qualitative data and presents the results per individual question, grouped by the four themes identified in the literature. The chapter will conclude with a summary.

4.2 Data collection process

A questionnaire was used as the data collection instrument (refer Appendix 2). In Chapter 1 (section 1.10.5) and Chapter 3 (section 3.6.3), it was explained that a new questionnaire was developed through reviewing extant literature and to address the research problem. This questionnaire was based on themes identified in the literature. The questionnaire was transferred to an online survey tool - Questionpro - available on its website (www.questionpro.com). A link to the survey was obtained (https://bigdatamanagementaccountancy.questionpro.com) and then distributed to participants by using email.

Since the phenomenon being studied is unique to management accountants in practice, a purposive sampling approach was adopted. Purposive sampling selects specific individuals or cases to provide the information needed to address the specific research problem (Johnson & Christensen, 2014:364). CIMA members and CIMA students in practice were therefore purposively sampled to complete the survey.

The sampled participants accessed the survey by clicking on the survey link provided above. The researcher kept track of completed surveys by regularly following the progress on the website https://www.questionpro.com/a/showVOCDashboardII.do?mode=default&lcfpn=false. The qualitative data was collected over a period of two months. After the data had been collected, an

analysis of the qualitative data was conducted. Similar to other research studies, the researcher experienced both challenges and positive aspects in the data collection phase.

4.2.1 Data challenges in the data collection phase

Initially there was a low response rate to the survey, requiring a follow-up process. Participants were regularly encouraged to complete the survey. Notwithstanding, not all participants completed the survey. The total number of people who viewed the survey was 124. A total of 21 attempted, 5 dropped out before completing the survey, while only 16 completed it.

4.2.2 Positive aspects of the data collection phase

The 16 participants who did complete the survey, did so in detail. This allowed for an in-depth analysis of the research problem. Additionally, participants were able to share the link to other members through email, thereby fulfilling the referral chain approach as described in Chapter 1 (section 1.10.3) and Chapter 3 (section 3.6.2). The online survey software utilised ensured that participants were able to maintain anonymity when completing the survey, resulting in a strengthened ethical approach (refer section 1.11 in Chapter 1 and Chapter 3). For convenience purpose, the target population for the research was CIMA members in South Africa. The majority of the participants (14 out of 16) were South African CIMA members and students in South Africa, with two CIMA members and students from Zimbabwe. Overall, the target of South African CIMA members and students as a study population had been achieved.

4.3 Data analysis

The purpose of this section is to analyse the qualitative data collected through the online survey to achieve the main research objective detailed in Chapter 1, section 1.8.1. Chapter 3, section 3.6.4 detailed the data analysis approach. In designing the questionnaire, the questions were constructed based on the themes identified through literature.

An item constitutes a theme if it contributes to answering the research question (Braun & Clarke, 2006:82). A theme interprets a phenomenon by the analysis of phrases and sentences to establish if they represent the essence and essentials of previous studies (Braun & Clarke, 2006:79; Saldana, 2015:140). In this chapter, responses from participants were linked to the research questions. In return, the responses were compared to extant literature to determine if they support, contradict or create new findings that prescribe a solution to the research objective.

The questions are analysed according to the following categories, as stipulated in the questionnaire:

1. General questions relating to the topic.

2. Theme 1: Management accounting change due to technology/change in business environment. Derived from literature review Chapter 2, section 2.2.

3. Theme 2: Impact of big data on corporate strategy. Derived from literature review Chapter 2, section 2.3.3.

4. Theme 3: Impact on the management accountant. Derived from literature review Chapter 2, section 2.3.4.

5. Theme 4: Skills of a management accountant. Derived from literature review Chapter 2, section 2.3.4.

Each of these categories will now be discussed.

4.3.1 General questions relating to the topic

This section of the questionnaire comprised two questions with the aim to determine the participants' knowledge around the concept of big data.

1. What is your understanding of the big data phenomenon?

The objective of the question was to obtain a generalised view of the participants' understanding of big data as a phenomenon. The question was open-ended, allowing a wider scope interpretation. The question was important as it assessed participants' familiarity with what is being studied.

All participants identified the big data phenomenon as large, massive or exponential growth in business data / information. Other terms used were "*large quantities", "large data sets", "large pools of data"* and "*mass quantity"*. When analysed from a causal perspective, participants highlighted that big data is due to internet and technology-based business environments, business growth and the interconnection of devices in a network.

With regard to the purpose of big data, the majority of participants highlighted that big data, if analysed, aids in decision-making. Specific benefits noted by participants included: "*improved decision making*", "*better business insights*", "*competitive advantage*", "*more efficient*", "*better serve customers*", "*market retention*" and "*product development*". Based on the above analysis, it

can be summarised that the big data phenomenon relates to large volumes of data which, when analysed, aids an enterprise in decision-making and in having improved competitive advantage.

The above analyses concurs with the literature reviewed in Chapter 2, section 2.3.3, which posits that big data motivates firms to reconsider their business models and strategy (Bhimani, 2015:8; Oesterreich *et al*., 2019:2; Rachinger *et al*., 2019:1144) through productivity, innovation and growth (Bhimani, 2015:7; Charles & Gherman, 2013:107). Big data analysis assists in understanding consumer behaviour, is used to bolster service delivery and for product innovation, to increase sales growth, and to improve customer relations (Gartner & Hiebl, 2018:1; Raguseo, 2018:3). Big data is useful for defending competition by acting as a barrier to entry, and for market enhancement (Grover *et al*., 2018:392).

It can therefore be concluded that participants' responses were in line with the literature and it indicates that they have a clear understanding of the concept of big data.

2. What is your definition of big data?

The objective of the question was similar to that of the first one, as it was aimed at determining whether participants were familiar with the research topic. However, this question was more specific in asking the meaning of big data. It therefore required participants to specifically define big data.

The majority of the participants (15 out of 16) defined big data in terms of large volumes of data. Terms used included "*lots of information*", "*massive volumes of raw data*", "*data from all sources*", "*huge unstructured and structured data*", "*information that is generated continuously from numerous digital platforms*", and "*vast amounts of data*". One other element included in the definition is that the large volume of data makes sense only after further analysis or processing. Participant 16 mentioned that it is *data "not possible for a human to look at …and make sense of it"* and "*too complex to make sense of without further processing*".

The definitions provided by the participants are in line with the definition of big data provided in Chapter 2 (section 2.3.1), which defined big data as data sets of high volume, high velocity, high variety and a complex veracity structure, often referred to as the 4Vs (Gartner & Hiebl, 2018:2; Power, 2014:223). It can therefore be gathered that the participants could define the concept of big data.

4.3.2 Management accounting change due to technology / change in business environment

This section of the questionnaire comprised seven questions with three of the questions requiring motivation for the participant's selection.

3. *Based on your opinion, has management accounting practice changed in your organisation due to the big data phenomenon?*

The objective of the question was to address research objective 1 in Chapter 1, section1.8, which seeks to review the historical development of management accounting and the causal factors for its change over time.

Underpinning the question is the institutional framework for management accounting change. The extended framework, as explained in Chapter 1, section 1.6, posits that "*generalised practices which are underpinned by the broader institutions could be imposed on the organisation by powerful external actors, or taken up within the organisation by groups who possess sufficient power to impose new rules*" (Ter Bogt & Scapens, 2018:16). It is further argued that the introduction of big data may be regarded as the powerful external actor, with management's requirement for new information due to technological changes representing internal actors who possess sufficient power to impose new rules (Ter Bogt & Scapens, 2018:16).

The majority of participants stated that management accounting practice has changed in their organisations due to the big data phenomenon. The finding concurs with the theoretical framework of institutional change, as described in the paragraph above. Further, participants' feedback agrees with the literature review in Chapter 2, section 2.2.6, where Kristandl (2014:5) argues that, given the historical adaptation of the management accounting profession to changes in business environment, it would be no exception if a major shift is expected in the practice of management accounting due to the big data effect.

4. *If yes, please explain how it has changed.*

The objective of the question was to capture detailed information about how the management accounting practice has changed due to big data. This was relevant to obtain a deeper understanding of the change process. Based on the analyses of the responses, the change process is still at an infancy stage.

Changes mentioned by respondents include the ability to analyse dark data for trends and cost behaviour, quicker interrogation of data, a move away from a focus on accuracy of manual entry in analysing the impact of data and predicting outcomes, and timely reporting and modelling of

risk. Other changes mentioned by participants include the ability to profile customers, which would assist marketing efforts to bring new business and to retain loyal customers. Big data avails managers with direct access to information in electronic format, resulting in faster decision-making.

5. *Are you facing challenges in your organisation in the practise of management accountancy due to the big data phenomenon?*

The objective of the question was to address the requirement set in Chapter 3 (section 3.6.1) which advanced the use of ADR to solve a problem encountered in an organisational setting per Sein *et al*. (2011:40). Mullarkey and Hevner (2019:8) advanced the problem formulation stage by positing that ADR may be applied at a much earlier stage of the process as a means to identify the fundamental aspects and underlying factors of a research problem. The problem-centred entry point denotes a stage where the research problem is not yet well understood. A diagnosis stage is then adopted as an entry point to understand the research problem (Mullarkey & Hevner, 2019:15). This question in the questionnaire probes the research question at the diagnosis stage to determine challenges faced by management accountants in their practice due to the big data phenomenon; if yes, then to gain an understanding of the problem faced in order to diagnose it. A follow-up question was therefore posed to participants as presented below:

6. *If yes, please explain the challenges you face.*

Fifteen out of the 16 participants stated that they were facing challenges in their respective organisations in the practise of management accounting due to the big data phenomenon. Challenges identified included: "*lack of skill set by finance professionals*", "*low quality data leading to misleading conclusions*", "*error in processing big data*", "*lack of confidence in making decisions based on big data*", "*limited storage capacity*", and "*lack of a proper big data software*".

One participant highlighted being overwhelmed with big data for both processing and use in decision making.

> "*Data is just too much. We are getting to a point we no longer understand firstly why we are collecting it, what to do with it and how to use it to our advantage*". – Participant 7

Participant 7's view concurs with the literature review in Chapter 2 (section 2.3.4) where Gartner and Hiebl (2018:11) posit that decision makers are confronted with a challenge of selecting relevant data from a lake of infinite data, thereby resulting in information overload. Charles and Gherman (2013:1072) also raise a concern about how do big data users know if the information

source about the customers, market, product and services to capture and analyse is accurate and reliable or not.

7. *What management accounting techniques, in your opinion, are becoming irrelevant in your organisation due to the big data phenomenon?*

The objective of this question was to validate the question posed in question 3. The question validated if management accounting practice is changing due to the arrival of big data. This was achieved by asking respondents to state which accounting techniques are falling away. Feedback from respondents included that: "*management opinions are being replaced by evidence and fact-based decisions*", "*management control systems are being replaced by cybersecurity and information security*", "*the skills required for a management accountant are now more digital-based*", and "*time spent on trend analysis is now being replaced by computer applications*".

Participant 7 did not see a change in management accounting techniques, but rather an automation of some of the techniques. While this finding agrees with Rikhardsson and Yigitbasioglu (2018:46), who highlight that inventory valuation, depreciation calculation and asset valuation will become automated, Gartner and Hiebl (2018:11) argues that new costing methods will develop to align with new cost structures in line with new production methods shaped by big data technologies.

8. *In your opinion, are there new management accounting techniques developing in your organisation due to the big data phenomenon?*

The question complements the previous question by probing participants to state emerging management accounting techniques. The objective is to prove or disprove whether new management accounting techniques have emerged due to the arrival of big data. This question was followed up with another question:

9. *If yes, please explain.*

Nine out of 16 of participants affirmed that there are new management accounting techniques emerging due to the big data phenomenon. Approaches and techniques mentioned by participants included: "*cloud accounting", "incorporating non-textual data in reporting such as pictorial when expressing customer sentiments".* Since data is made available directly in electronic form to management*, "management accountants have an added practice of validating the data"*. Data mining, analysis and visualisation were cited as the main techniques that management accountants focus on in a big data environment. This is in agreement with the literature review argument by Phillips-Wren and Hoskisson (2015:89), who identified skills in data

analytic software, statistical and financial modelling, strategic problem identification, critical thinking skills and an ability to effectively communicate results as key skills required for management accountants in a big data environment.

4.3.3 Theme 2: Impact of big data on corporate strategy

This section of the questionnaire comprised three questions.

10. *What strategy, in your opinion, does your organisation follow between differentiation, cost leadership, focus? Please motivate your choice.*

The objective of the question was to address the second secondary research objective in section 1.8.2 of Chapter 1, as well as the literature review in Chapter 2 (section 2.3.3) which affirm that companies with the ability to harness big data for decision-making will have a competitive advantage (Charles & Gherman, 2013:1071). To address this objective, the researcher formulated a question to determine if an entity is following a specific strategy. A follow-up question was posed (question 10), which was how the organisation was using big data to gain competitive advantage.

Participants did mention that the entities they work for do apply a strategy. The majority of the participants (7 out of 16) identified differentiation as the strategy followed, with cost leadership ranking second (4 out of 16), and the focus strategy was ranked last (2 out of 16), with 3 participants mentioning a mixed strategy.

11. *How is your organisation using big data to aid corporate strategy?*

This question is linked to question 7, posed and discussed above. The objective of the question was to determine how big data is being used to support corporate strategy. The qualitative responses were compared with the literature review in Chapter 2 (section 2.3.3). The previous research on the topic posit that big data creates new informational insights in the business environment by creating new challenges and opening new opportunities that force and motivate firms to reconsider their business models and strategy (Bhimani, 2015:8; Oesterreich *et al*., 2019:2; Rachinger *et al*., 2019:1144). The advent of big data technologies is re-shaping, transforming and revolutionising the business environment (Grover *et al*., 2018:390; Wamba *et al*., 2017:357).

The last question in this section of the questionnaire asked the participants the following:

12. How is your organisation using big data to gain competitive advantage?

Participant 1 mentioned that they use big data in their organisation to "*identify gaps in the market"*, and "*improve the quality of service rendered to customers"*. Participant 2 made reference to the comment below on how their organisation is using big data:

> "*We have developed models that assist in cost reduction, improving sales, debt collection, shortest path model for the logistics team to reduce costs of delivery per trip*." – Participant 2

Other participants responded by highlighting that a "*consumption prediction model for commercial consumers"* has been developed, as well as "*planning stock holding positions"* and predetermining when customers would need a product. Big data is used to identify patterns and trends from customer activity that directs decision-making.

Big data is also used for:

> "*Live tracking of project"* to ensure that they are completed on time and within budget. It "*keeps management informed of capital expenditure incurred"* and what is still available – Participant 7

It works as an early signal upon which action is taken timely. Information is readily available through trend analysis, and big data models produce projections in sales, expenses and inventory levels.

> Big data "*decreases turnaround time"* and "*helping the companies to serve client quicker"* – Participant 15

> Big data technology can be adapted for use on "*market benchmarking and market penetration analysis"* – Participant 16

From the perceptions of the participants, it can be gathered that big data and big data analysis are used to assist organisations in meeting its strategies.

4.3.4 Theme 3: Impact on the management accountant

This section of the questionnaire had the highest number of questions per section as it comprised seven questions.

13. *Do you think you have influence as a management accountant in your organisation to implement big data driven technology/ies for management accountancy practice?*

The objective of the question was to determine if management accountants have a voice in the implementation of new big data technologies. Big data aids decision making (Wamba *et al*., 2017:358). Management accountants analyse data to aid decision making (Nelson, 2018:179). There is therefore a link between big data and management accounting. As a result, it is argued that management accountants should act as advocates in the implementation of big data technologies.

A follow-up question was asked:

14. *If yes, please explain how.*

Nine out of 16 participants affirmed that they play a major role in the implementation of big data driven technologies. Participants stated that they contribute in areas such as providing guidance in which big data technology to adopt. One participant had successfully recommended the implementation of PowerBI analytics in their organisation. While Patrizio (2018:1) posits that there is no blanket packaged software to serve all potential customers across industry, Rikhardsson and Yigitbasioglu (2018:46) suggest that, since management accountants already have business acumen, they are better positioned to select big data technologies that is more relevant to decision-making. This is in line with research feedback where participants indicated that they had contributed in the implementation of big data technologies in their organisations.

15. *Are you using big data driven software in your organisation in the practice of management accountancy? If yes, please give details of the software used.*

The aim of the question was to establish whether management accounting practice is evolving to include the use of big data technologies to provide information for decision-making.

The majority of participants confirmed that they use big data driven software in their respective organisations. The participants mentioned software such as PowerBI, Abaca, Azure, and SAP BI.

The following two questions of the questionnaire had the same objective and are therefore discussed together.

16. *What shortfalls do the big data analytics applications you use, or available in the market, have in meeting the requirements and functions of management accountancy?*
17. *What features and capabilities should a big data driven management accountancy technology have?*

The objective of these questions was to follow the ADR approach stated in Chapter 3 (section 3.6.1) of seeking to solve a problem encountered in an organisational setting through interaction with participants (Sein *et al*., 2011:40). Management accountants, as individuals who are directly impacted by the phenomenon, were allowed to prescribe a solution to the shortfalls in terms of the features and functioning of big data driven management accountancy software.

Suggestions made by participants include, "*dashboard cloud- based analytics*", a combination of tools that extract both internal and external data, user friendly, "*robust reporting capabilities*", a software "*able to handle large sets of data*", automated data collection, allow querying of data, ability to collect both financial and non-financial information with no data capacity constraints. Based on the feedback from participants, a big data driven management accountancy technology should be cloud based, of a dashboard format, with the ability to handle large data sets and a capability to collect both internal (from the ledger) and external data from which, if a query is run, it is able to produce a robust report that can be exported into other formats.

> "*Data collection sources should be semi-automated and possibly strengthened by AI technologies. Reporting tools should be flexible and be able to easily export information to analysis software to be used by lower level resources such as Excel etc. for additional reporting purposes. Cross compatibility is a must.*" – Participant 13.

18. *How can the traditional management accounting practices, such as target costing, budgeting, break-even analysis, product profitability analysis and performance evaluation be incorporated into a big data driven analytic system?*

The objective of the question was to determine if traditional management accounting techniques can be incorporated into big data technologies, and also to test which traditional management accounting practices are becoming irrelevant due to big data. Two participants out of 16 stated that the question was too broad and open for interpretation. However, the main point raised by other participants was that while "all the accounting information is already in the ledger", an application should be built so as to incorporate the information already in the ledger as well as the information collected from external sources, and then to "use it for bench-marking, breakeven

analysis, profitability analysis". For performance evaluation, the approach should be to build a big data reporting tool "based on the balanced scorecard" model.

19. *Do you think we can incorporate social media data into a big data driven management accountancy system? If so, please explain how.*

The objective of the question was to determine how, and to what extent, non-financial information can be incorporated into management accounting reporting. One of the sources of big data is social media (Clayton & Clopton, 2019:1; Raguseo, 2018:8).

Participants had mixed reactions to the question, with some questioning the validity of social media data. However, 12 out of 16 participants mentioned that social media data should be incorporated into management accounting reporting as non-financial information. They posit that social media data provides customer sentiments and feedback which, when analysed, provides insight into how to better serve customers. It enables companies to see what others are doing in their companies. Such information can be used for "benchmarking or competitor analysis". Information collected from social media can also be used for "budgeting" and it provides insight in market projection.

> *"I think for companies that market products for general public can do that. Check the trends of consumers, making products for specific target group based on social media need analysis. Customer perception about company product can also be gained from social media."* – Participant 8

The last section of the questionnaire was aimed at collecting data to support or contradict literature around the skills required by management accountants to utilise opportunities created by big data.

4.3.5 Theme 4: Skills of a management accountant

This last section of the questionnaire was focused on the fourth theme identified through the literature review, i.e. the skills of a management accountant. This section comprised one question.

20. *What skills do you need to develop as a management accountant in order to effectively utilise the big data opportunities?*

The objective of the question was to determine if management accountants need to develop new skills to meet the requirements of big data. The question's aim was to prove or disprove Gartner and Hiebl's (2018:1) claim that, dealing with big data, could be a hindrance to the management accountant's role in a big data environment due to their lack of IT skills in data analysis.

All the participants (16 out of 16) responded that management accountants need to develop new skills in order to take hold of the opportunities offered by big data. The skills mentioned included an understanding of programming, machine learning, data visualisation, analytical, digital skills, IT skills, Structured Query Language (SQL), data governance, data management, artificial intelligence, data modelling, front and back-end knowledge, data mining, communication and interpretation skills.

From the responses it can be gathered that management accountants have to develop additional skills to fully utilise the value offered by big data and big data analyses. This supports Gartner and Hiebl's (2018) argument. The researcher analysed the data as each participant completed the questionnaire. As the data was being analysed, it was noted that the first few participants could contribute a new point that was not mentioned by previous participants. However, when participant 14 was reached, the points mentioned were similar to what was already mentioned by other participants. The researcher discontinued collecting new data at participant 16 when no new information was being collected. This research considered this level as the point of saturation. Summary

The aim of this chapter was to mainly address the third secondary objective as set in Chapter 1, namely that of empirically exploring the use of big data and big data analytics by management accountants in their practices, roles and decision-making. The chapter started by explaining the data collection process, followed by the challenges and positive aspects encountered in the data collection process. The data analysis process was then reiterated by describing the structure and contents of the survey.

The results of the survey questions, grouped into five themes, were discussed using the following headings: 1) general questions relating to the topic; 2) Theme 1: Management accounting change due to technology/ change in business environment; 3) Theme 2: Impact of big data on corporate strategy; 4) Theme 3: Impact on the management accountant; and 5) Theme 4: Skills of a management accountant.

The responses to each question (under each theme) were discussed and linked to the literature study to determine whether they supported or contradicted it, or whether they created new findings that prescribe a solution to the research problem.

The next and final chapter will summarise the research findings, draw a conclusion and end with recommendations for further research.

CHAPTER 5

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

An analysis of the empirical study was done in Chapter 4 as a basis of the research conclusion. Chapter 5's aim, as stated in Chapter 1 section 1.8, is to achieve the final objective of the research study of drawing a conclusion based on the data analysis done in Chapter 4, and to make recommendations for further research.

In chapter 1 (section 1.5, page 4) it was highlighted that the study aims to define the gap in literature around management accounting practices and the role of management accountants in the era of big data. Furthermore, this study was focused on diagnosing the problem described in chapter 1 (section 1.7, page 9) which represents the first stage of the ADR process (refer chapter 3, section 3.6.1, page 37).

The conclusion marks the end of the research work, opening opportunities for future research. The chapter starts by reiterating the background to the study and the research findings on the individual study objectives, followed by putting forward limitations of the study, and lastly making recommendations for further study.

5.2 Background to the study

Chapter 1 (section 1.1) argued that trends in the business environment, including technological advancement, can lead to a change in corporate strategy, thereby creating a change in informational demand by managers. The new informational demand consequentially changes the management accounting role and practices in an organisation.

It was also noted in Chapter 1 (section 1.1) that the global business environment is currently experiencing a shift in its competitive strategy, operational structure and production methods due to advancement in technology, including the big data phenomenon. Consequentially management accounting practice is expected to change.

5.3 Research synopsis

This research synopsis provides an overview of the primary and secondary objectives, as set in Chapter 1 (section 1.8), by reviewing each objective and indicating whether it has been achieved.

5.3.1 Primary objective

To explore the use of big data and big data analytics by management accountants in management accounting practices and decision-making.

The main objective of the study was to explore the use of big data and big data analytics by management accountants in management accounting practices and decision-making. In achieving the research objective, an approach to find a solution to the research problem from the participants' perspectives, and within an organisational setting, was followed. In order to prescribe a solution, the research problem was diagnosed, following an ADR approach as described in Chapter 3 (section 3.6.1). A problem identification approach was followed. According to Sein *et al*. (2011:40), the problem-solving approach is addressed by applying the first stage of the ADR method, referred to as "problem formulation" (refer Figure 3-1). This stage is regarded as the research trigger as it is at this stage that a problem is perceived (Sein *et al*., 2011:40).

In order to find a solution to the research problem, the study was directed to management accountants who were in practice (at that time), experiencing the phenomenon in the real world. Through the qualitative data collected and analysed, key findings were made which are discussed below.

- The diagnosis of the problem includes that there is a lack of proper big data software in dealing with big data, resulting in low quality data that leads to deceptive conclusions and errors in the processing of big data. As a result, there is lack of confidence in making decisions based on big data. Additionally, due to the big data phenomenon, computer capability has limited storage capacity. Big data users are overwhelmed with big data for both processing and for using in decision-making.

- Management accountants – as individuals directly impacted by the phenomenon – were allowed to prescribe a solution in terms of the features and functioning of big data-driven management accountancy software. Suggestions made by participants included a dashboard cloud-based analytics, a combination of tools that extract both internal and external data, user-friendly application with robust reporting capabilities, software able to handle large size of data, and an automated data collection process which allows the querying of data with an ability to collect both financial and non-financial information with no data capacity constraints.

- In prescribing a solution to the diagnosed problem, the participants suggested that big data application software should be built in a way that incorporates the information already in the accounting ledger, as well as information collected from external sources. This information can be used for decisions such as benchmarking and breakeven analysis or profitability

analysis. For performance evaluation, the solution is to build a big data reporting tool based on the balanced scorecard model.

- One of the sources of big data is social media. The findings were that social media data should be incorporated into management accounting reporting as part of non-financial information. Data sets from social media provide customer sentiments and feedback which, when analysed, give insight into how to better serve customers. It enables companies to see what others are doing in their companies. Such information can be used for benchmarking or competitor analysis. Information collected from social media can also be used for budgeting, since it provides market insight.

Since problems experienced by management accountants pertaining to big data and big data analytics were identified and a possible solution to the problem recommended, the main objective was met. The fulfilment of the above main objective is supported by findings from secondary objectives as described below.

5.3.2 Secondary objective 1

To review the historical development of management accounting and the causal factors for its change over time (Chapter 2).

This objective was addressed in Chapter 2 (section 2.2). The extended institutional framework for management accounting change, described in Chapter 1, formed the theoretical framework for the study. This theory argues that external institutional pressures and changes within an organisation may bring about management accounting practice change.

The determinants of management accounting change were noted to be improved production methods, improved technology and increasing globalisation. Changes in management accounting practice were evaluated from a historical perspective and it was noted that management accounting practice has changed and evolved since the pre-industrial revolution to the fourth industrial revolution, due to changes in the business environment.

Kaplan supported this argument in the 1980s when he highlighted the need for management accounting practice to change, due to changes in the business environment. The change in business environment was caused by advancement in production technology and a shift in competitive forces, against a static management accounting practice (Johnson & Kaplan, 1987:24; Kaplan, 1984:390). The arrival of big data constitutes a change in the business environment, and as a result, management accounting practice is expected to change in order to adapt to the effect of big data.

Since the historical development of management accounting and the causal factors for its change over time was addressed, secondary objective 1 was achieved.

5.3.3 Secondary objective 2

To define big data and discuss whether and how it disrupts strategy; the organisational information need; and the role of the management accountant (Chapter 2).

Chapter 2 (section 2.3.3) addressed the second secondary objective. Big data was defined as datasets too vast for processing through the traditional data-processing systems (Appelbaum *et al*., 2017:31; Janvrin & Watson, 2017:8; Power, 2014:223; Raguseo, 2018:3). Big data characteristics include sheer volume, veracity and speed exceeding the organisation capacity for storage, accuracy analysis and expediting the decision-making process (Phillips-Wren & Hoskisson, 2015:89; Raguseo, 2018:3). The definition for big data was supported by the participants as confirmed by the research study findings in Chapter 4 (section 4.3) where participants defined big data as:

> "*lots of information*", "*massive volumes of raw data*"*, "data from all sources", "huge unstructured and structured data", "information that is generated continuously from numerous digital platforms and vast amounts of data".*

The literature review presented in Chapter 2 (section 2.3.3) posited that big data creates new informational insights in the business environment, thereby creating new challenges and opening new opportunities that force and motivate firms to reconsider their business models and strategy (Bhimani, 2015:8; Oesterreich *et al*., 2019:2; Rachinger *et al*., 2019:1144). Big data is a game changer in the business environment. The advent of big data technologies is re-shaping, transforming and revolutionising the business environment and is confirmed to be disrupting the business strategy (Grover *et al*., 2018:390; Wamba *et al*., 2017:357).

Since big data was defined, followed by a discussion of how it can disrupt strategy as well as the role of the management accountant, secondary objective 2 was met.

5.3.4 Secondary objective 3

To discuss the philosophical underpinnings and formulate the research design and methodology adopted to achieve the set research objective (Chapter 3).

Chapter 3 (section 3.5) discussed the research design and methodology followed in this research study. A qualitative approach was followed. Qualitative research is a method that seeks to find a solution to a research problem through the collection of non-numeric data (Johnson &

Christensen, 2014:82). It is exploratory and knowledge is generated from a groundwork perspective through the study of a phenomenon in its natural settings (Johnson & Christensen, 2014:84). An ADR approach was followed. This approach was explained in detail in Chapter 3 (section 3.6.1) and is summarised in this chapter.

Qualitative research uses an explanation of participants' experiences, beliefs and values to obtain an understanding of sophisticated processes, situations and reality (Creswell, 2014:32; Queiros *et al*., 2017). Data can be collected using interviews, participants' observation or open-ended questions (Johnson & Christensen, 2014:85). In this study, an open-ended questionnaire approach was used. The data collected was analysed using a descriptive approach through the use of themes in which the researcher interpreted the data to discern knowhow. A thematic analysis of the data was performed as part of reaching secondary objective 4, and is presented in section 5.3.5 below.

Since a research design and methodology to achieve the set research objective was formulated and applied, secondary research objective 3 was accomplished.

5.3.5 Secondary objective 4

To empirically explore the use of big data and big data analytics by management accountants in their practices, roles and decision-making (Chapter 4).

The study was categorised into four themes based on the literature review. The questionnaire was also developed based on these themes. Qualitative data was collected from 16 participants. The findings per theme based on the analysis of this qualitative data are detailed in the section that follows.

Theme 1: Management accounting change due to technology / change in business environment. Section: 2.2 of Chapter 2

Based on the analysis of participant feedback stated in Chapter 4 (section 4.3), management accounting practice has changed within organisations due to the arrival of big data. The finding supports Kristandl's (2014:5) argument, stated in the literature review in Chapter 2 (section 2.2), that management accounting practice is expected to change in tandem to its historical trend of changing whenever there is a shift in the business environment.

Management accounting practice changes, projected by participants, are the following: the ability to analyse dark data for trends and cost behaviour, quicker interrogation of data, a move away from focus on accuracy of manual entry in analysing the impact of data and predicting outcomes, and timely reporting and modelling of risk. Also noted by respondents is the ability to profile

customers, a process which boosts marketing efforts in bringing in new business and retaining loyal customers. Lastly, big data offers direct access to information in electronic format to managers. This results in prompt decision-making.

Challenges experienced by management accountants in their organisations emanating from the big data phenomenon are: the lack of a skill set by finance professionals, low quality data leading to misleading conclusions, error in processing big data, lack of confidence in making decisions based on big data, limited storage capacity, and lack of a proper big data software. With regard to management accounting techniques that are becoming irrelevant, it was noted that management professional judgement is being replaced by evidence- and fact-based decisions, and management control systems are being replaced by cybersecurity and information security. New management accounting techniques developing as a result of big data include cloud accounting and incorporating non-textual data in reporting, such as in picture format, in displaying customer feedback and reaction.

Theme 2: Impact of big data on corporate strategy. Section: 2.3.3 of Chapter 2

Within an organisational setting, big data is used to assist in identifying market gaps and opportunities. It is also used as source of information for product development and improvement, as well as improving quality of services provided to customers. Big data technology has also found use in developing models that assist in cost reduction. Other models developed include efficient debt collection, and shortest path model for the logistics team in delivery of goods. Additionally, models were developed to predict commercial consumption, setting inventory holding positions and predetermining customers' needs. In doing so, big data has found use in identifying patterns and trends from customer activities which management can then use in decision-making.

Big data technology has also found use in live-tracking of projects. Live-tracking of projects ensures that projects are completed as planned and within budget. This then makes big data a project management tool and budget tracker. Management is kept informed of capital expenditure incurred, projected expenditure and what funds that are still available. If properly applied, big data technology works as an early signal which triggers management action in time. This is so because information is readily available in an electronic form from which trend analysis and big data models to produce projections in sales, expenses and inventory levels can be performed. A notable advantage of big data technology is its ability to decrease the turnaround time, thereby enabling organisations to serve clients quicker. Big data technology can also be modelled to collect information used for market benchmarking and market penetration analysis.

Theme 3: Impact on the management accountant. Section: 2.3.4 of Chapter 2

From the empirical study findings in Chapter 4 (section 4.3), it was noted that management accountants are now using big data driven software to execute their functions in organisations. The most common applications used are: Power BI, Abaca, Azure and SAP BI. Such applications were noted to have robust reporting capabilities and can handle large sizes of data. In applying the above big data applications, decision-making can be based on a pattern over time. Where management notices a consistent pattern over time, a decision can be made on that basis, making the "why" part of the decision-making process irrelevant.

The literature review performed and presented in Chapter 2 (section 2.3.4) supports the above development by positing that certain management accounting techniques will become irrelevant in a big data environment. Certain management accounting techniques will be replaced by big data technologies (Oesterreich *et al*., 2019:11; Rikhardsson & Yigitbasioglu, 2018:46). As an example, employee behaviour can be controlled and evaluated by using real-time events such as customer voice patterns on sales calls. Such data can be used for improving customer experience. Big data can also be used to monitor customer online search patterns and shopping behaviour in order to develop a customer product recommendation (Rikhardsson & Yigitbasioglu, 2018:43).

Theme 4: Skills of a management accountant: 2.3.4 of Chapter 2

There is a need for management accountants to develop new skills in order to be able to handle big data. Skills that management accountants need to develop include: programming, machine learning, data visualisation, analytical, digital skills, IT skills, SQL, data governance, data management, artificial intelligence, data modelling, front and back-end knowledge, data mining, communication and interpretation skills.

Since an empiric exploration of the use of big data and big data analytics by management accountants in their practices, roles and decision-making was performed, secondary research objective 4 was achieved.

5.3.6 Secondary objective 5

To conclude and make appropriate recommendations on the research study conducted (Chapter 5).

The first part of this objective has been achieved by this chapter thus far. The limitations to the study are addressed in section 5.4 below. Appropriate recommendations based on the results of

the study is done in section 5.5, and areas for further study is addressed in section 5.6. This objective was achieved through the completion of this chapter.

5.4 Limitations to the study

The following are limitations to the study:

- While the study population was considered adequate to draw a conclusion, it was mainly limited to a South African population and not done at a global level.
- The study was limited to CIMA members and students. There are other management accountants belonging to other professional bodies who were not included in the population due to the difficulty in identifying such individuals.
- Since the study is exploratory, it was limited to the problem formulation phase of the diagnosis stage of the ADR process.

5.5 Recommendations

Application software such as Power BI, Abaca, Azure and SAP BI have the capabilities to perform big data driven management accounting practice. It is recommended that management accountants adapt the use of such applications in their organisations to perform their function as management accountants.

Since big data will result in new application software used to perform management accounting practices, it is recommended that management accountants should develop big data skills in order to be able to handle big data and to remain relevant in the management accounting profession. Such skills include programming, machine learning, data visualisation, analytical, digital skills, IT skills, SQL, data governance, data management, artificial intelligence, data modelling, front and back-end knowledge, data mining, communication and interpretation skills.

5.6 Areas for further study

The recommendations pertaining to areas for further study around the topic will address the limitations identified in this study:

- Expand the study population beyond South Africa to a global level in order to obtain a global perspective of the phenomenon.

- Expand the study population beyond CIMA members only in order to gain a broader perspective of the impact of the phenomenon to the management accounting practice and strategy.

- Extend the study beyond the problem formulation stage of the action design research and artefact building stage of the ADR process.

5.7 Summary

The main objective of this study was to explore the use of big data and big data analytics by management accountants in management accounting practices and decision-making. In achieving the research objective, an approach to find a solution from the participants' perspective and within an organisational setting was followed. The main research objective and the secondary objectives were achieved and then summarised in this chapter.

This chapter started by reiterating the background to the study (section 5.2), followed by a research synopsis (5.3) and presentation of the research findings on the primary (section 5.3.1) and secondary study objectives (section 5.3.2 – 5.3.6). Limitations to the study were addressed in section 5.4, followed by recommendations (section 5.5) and areas for further study (section 5.6). This concludes the study.

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ANNEXURE 1: QUESTIONNAIRE

INFORMED CONSENT AND QUESTIONNAIRE

TITLE OF THE RESEARCH STUDY:

Exploring the use of big data analytics by management accountants in decision-making

ETHICS REFERENCE NUMBER: NWU-00808-20-A4

SUPERVISOR: Prof SL Middelberg

CO-SUPERVISOR: Prof PW Buys

POSTGRADUATE STUDENT: Reuben Masuke

STUDENT NUMBER: 33158894

E-MAIL ADDRESS: reuben.masuke@yahoo.com

CONTACT NUMBER: 073 176 0464

You are invited to take part in a research study that is in partial fulfilment of a master of commerce in management accountancy degree. Please take some time to read the information presented here, which will explain the details of this study. Please ask the researcher, or person explaining the research to you, any questions about any part of this study that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research is about and how you might be involved. Also, your participation is entirely voluntary and you are free to say no to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part now.

This study has been approved by the North-West University's (NWU) Economic and Management Sciences Research Ethics Committee (EMS-REC) (Ethics number: NWU-00808-20-A4) and will be conducted according to the ethical guidelines and principles of the NWU's Research ethics policy, and other international ethical guidelines applicable to this study. The EMS-REC reserves the right to audit this study to ensure compliance.

What is this research study all about?

The objective of the research is to explore how management accountants use big data and big data technologies in practice and how big data is changing the management accounting practice.

Why have you been invited to participate?

You have been invited to participate in this research because you are a professional management accountant with experience and practical exposure to the research area under study.

What will be expected of you?

You will be expected to spend about 30 minutes answering the research questions as provided in the online research questionnaire.

Will you gain anything from taking part in this research?

There will be no direct gain for you in the study. However, the study will contribute to the creation of the knowledge of how the management accountancy profession may utilise big data and big data technology to aid decision-making.

Are there risks involved in you taking part in this research and what will be done to prevent them?

There are no risks to you for taking part in this study. Your participation will contribute towards the creation of knowledge in the interaction of big data and the management accountancy profession.

How will we protect your confidentiality and who will see your findings?

All information provided by you will be handled with anonymity and confidentiality. As soon as the data has been compiled and analysed, it will be kept safe by password-protecting the electronic data. Data will be stored for five years.

What will happen with the findings or samples?

The information provided by you will be used for the research study purpose only and will not be shared with any third parties.

How will you know about the results of this research?

The results of the study will be published in the form of a mini-dissertation by the NWU.

Will you be paid to take part in this study and are there any costs to you?

There is no payment for taking part in this study. There is no cost involved for you if you take part in this study.

Is there anything else that you should know or do?

You can contact **Reuben Masuke (the post-graduate student)** at reuben.masuke@yahoo.com if you have any further questions or have any problems.

You can also contact the Research Ethics Committee (EMS-REC) if you have any concerns that were not answered about the research, or if you have complaints about the research.

Declaration by participant

By signing below, I agree to take part in the research study titled:

Exploring the use of big data analytics by management accountants in decision-making

I declare that:

- I have read this information/it was explained to me by a trusted person in a language with which I am fluent and comfortable.
- The nature and purpose of the research was clearly explained to me.
- I have had a chance to ask questions to both the person getting the consent from me, as well as the researcher and all my questions have been answered.
- I understand that taking part in this study is voluntary and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be handled negatively if I do so.

Signed at (place) .....…..…….. on (date) ……...…….. 20.....

Signature of participant……..

General questions relating to the topic

1. What is your understanding of the big data phenomenon?

_____

_____

_____

_____

2. What is your definition of big data?

_____

_____

_____

_____

Management accounting change due to technology/change in business environment

3. Based on your opinion, has management accounting practice changed in your organisation due to the big data phenomenon?

_____

4. If yes, please explain how it has changed.

_____

_____

_____

_____

5. Are you facing challenges in your organisation in the practice of management accountancy due to the big data phenomenon?

_____

6. If yes, please explain the challenges you face.

_____

_____

_____

_____

7. What management accounting techniques, in your opinion, are becoming irrelevant in your organisation due to the big data phenomenon?

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8. In your opinion, are there new management accounting techniques developing in your organisation due to the big data phenomenon?

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9. If yes, please explain.

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Impact of big data on corporate strategy

10. What strategy, in your opinion, does your organisation follow between differentiation, cost leadership, focus? Please motivate your choice.

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11. How is your organisation using big data to aid corporate strategy?

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12. How is your organisation using big data to gain competitive advantage?

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Impact on the management accountant

13. Do you think you have influence as a management accountant in your organisation to implement big data driven technology/ies for management accountancy practice?

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14. If yes, please explain how.

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15. Are you using big data driven software in your organisation in the practice of management accountancy? If yes, please give details of the software used.

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If your answer to the above question was yes, please answer this question:

16. What shortfalls do the big data analytics applications you use, or available in the market, have in meeting the requirements and functions of management accountancy?

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17. What features and capabilities should a big data driven management accountancy technology have?

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18. How can the traditional management accounting practices, such as target costing, budgeting, break-even analysis, product profitability analysis and performance evaluation be incorporated into a big data driven analytic system?

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19. Do you think we can incorporate social media data into a big data driven management accountancy system? If so, please explain how.

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Skills of a management accountant

20. What skills do you need to develop as a management accountant in order to effectively utilise the big data opportunities?

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Thank you for your participation

ANNEXURE 2: ETHICAL CLEARANCE CERTIFICATE

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

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South Africa 2520

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Economic and Management Sciences Research
Ethics Committee (EMS-REC)

24 August 2020

Prof Sanlie Middelberg and Prof Pieter Buys
Per e-mail
Dear Prof Middelberg and Prof Buys,

EMS-REC FEEDBACK: 31072020
Student: Masuke, R (33158894)(NWU-00808-20-A4)
Applicant / Study leader: Prof Sanlie Middelberg / Prof Pieter Buys – MCom in Management Accountancy

Your ethics application on, *Exploring the use of big data analytics by management accountants in decision-making*, which served on the EMS-REC meeting of 31 July 2020, refers.

Outcome:

Approved as a minimal risk study. A number NWU-00808-20-A4 is given for one year of ethics clearance.

Due to the Covid-19 lock down ethics clearance for applications that involve data collection or any form of contact with participants are subject to the restrictions imposed by the South African government.

Kind regards,

Mark Rathbone

Prof Mark Rathbone
Chairperson: Economic and Management Sciences Research Ethics Committee (EMS-REC)

ANNEXURE 3: LANGUAGE EDITING CERTIFICATE

MAGDA BURGER

LANGUAGE PRACTITIONER

[SATI Membership number : 1003227]

75 Munnik Street
STRAND
7140
Cell: 082 333 7541

2020-12-14

TO WHOM IT MAY CONCERN

LINGUISTIC REVISION OF MINI-DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

MASTER OF COMMERCE IN MANAGEMENT ACCOUNTANCY

AT THE NORTH-WEST UNIVERSITY

For

R Masuke : Student number: 33158894

I, Magda Burger, ID number 521006 0038 080, hereby declare that I have linguistically revised the mini-dissertation : *Exploring the use of big data analytics by management accountants in decision-making* for student R Masuke.

Yours sincerely

MAGDA BURGER
LANGUAGE PRACTITIONER
BA (Languages) (UFS) (1973); MEd (UFS) (1987)