Journal of
Risk and Financial Management

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Big Data's Disruptive Effect on Job Profiles: Management Accountants' Case Study

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Abstract: The abundance of new innovative data sources creates opportunities and challenges for all professions and professionals working with information. One of these professionals is the management accountant (MA). Although their tasks have expanded over time and especially recently, MAs have not fully employed all the available internal and external data sources to describe, diagnose, visualize, predict and prescribe possible solutions that enable smart decisions with positive effects on businesses. Thus, the paper investigates the impact of Big Data, including Data Analytics, on MA's job profile. Through a review of the most recent academic and professional publications, the paper contributes to the debate surrounding the redefinition of the role of MAs in organizations in a novel informational perspective of Abbott's theory. The results could serve as a research agenda and incentive for further studies, as well as provide MAs with a guide on the topic of the enlargement of their role(s), respectively, the augmentation of their tasks and responsibilities regarding the analysis of Big Data. Furthermore, the research may provide both a rich and flexible framework to help practitioners in their analysis of potential risks, opportunities and challenges when handling Big Data, and a lens for professional accounting associations and bodies by helping them to prioritize the holding and seizing of jurisdictions as an imperative part of safety and security.

Keywords: Big Data; Data Analytics; job profile; management accountant; Prescriptive Analytics; digital innovation; value creation

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Citation: Tiron-Tudor, Adriana, and Delia Deliu. 2021. Big Data's Disruptive Effect on Job Profiles: Management Accountants' Case Study. *Journal of Risk and Financial Management* 14: 376. https://doi.org/10.3390/jrfm14080376

Academic Editor: David J. Edwards

Received: 28 June 2021
Accepted: 10 August 2021
Published: 16 August 2021

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1. Introduction

The digital transformation of economies, as well as technological innovations, trends, and breakthroughs worldwide, are currently affecting all businesses, through enabling new more fluid and dynamic forms of cooperation and, thus, requiring companies to reflect on their business model and strategies (Möller et al. 2020). In the digital era, there is a tremendous variety of open data sources available on the Internet that requires specific data-processing software and hardware to handle it and advanced techniques for analysis. At the same time, there is an increasing request in using predictions and data-driven decision-making in organizations' practices. The new digital technologies like Blockchain, Big Data (BD), Data Analytics (DA), Robotic Process Automation, and Artificial Intelligence have revitalized the relationship between technology and the accounting profession (Vasarhelyi et al. 2015; Moll and Yigitbasioglu 2019; Tiron-Tudor et al. 2021). Moreover, it is expected that accountants' job profiles will be highly altered in the future by the synergic effect of all these disruptive technologies.

Management accountants (MAs) are in the best position to establish the data needed in terms of volume and type to support an organization, as they have a holistic view of an organization and its existing information systems (ACCA 2020a). Business managers rely on MAs' capability to monitor the business's costs and performance and to plan the business strategy (Appelbaum et al. 2017; ACCA 2020a, 2020b). Management accounting as

a profession involves collaborating in management decision-making, conceiving planning and performance systems, and supporting financial reporting and control to sustain top-management in defining and implementing an organization's strategies (IMA 2019; ACCA 2020c, 2020d).

Even if MAs' are accustomed to use diverse tools and technologies, digitalization is likely to disrupt their current practice, working data and tools, interactions with management and other departments, and requesting of new areas of competences (Quattrone 2016; Nielsen 2018; IMA 2019). Moreover, the BD phenomenon is rapidly influencing the role of MAs in extracting, handling, analyzing, and providing predictions useful to the management and decision-makers (Spraakman et al. 2015; Rikhardsson and Yigitbasioglu 2018; Oesterreich et al. 2019; Andreassen 2020; Bergmann et al. 2020; Bhimani 2020). Likewise, MAs' job description is changing by including more digital skills (Heinzelmann 2018; Richins et al. 2018). Whether the BD and DA will be included in the MA's job role or they will be taken by other new jobs remains an open question. In this context, Abbott (1988) theory of professions gains fresh relevance to the emerging information occupations of the 21st century (Furness 2019). His theory exposes professions in a rivalry for jurisdiction over solvable problems, as now it is the BD area. Thus, the MA profession is an interesting case to be explored, given the rapidly changing work environments through digitalization, being a so-called a profession of "quantitative" information.

The present study explores the critical relationship between BD and the MAs' job content. We aim to investigate how MAs deal with risks, opportunities and challenges provoked by the emergence of BD in business, by reviewing the scientific literature and professionals' reports. The study is attempting to formulate answers to the following research question:

> *RQ: How does Big Data influence MAs' job profile regarding responsibilities and duties, and qualifications and skills required?*

This study contributes to the development of knowledge in the management accounting field in multiple ways. Firstly, the study reveals the possible risks for MAs' job role boundaries as other already existing or new professions are entering in the BA management and analysis arena. Secondly, it highlights the set of opportunities raised by BA for MA summarizing what are the new areas and proactive responsibilities of MAs and how the profession might adapt to the new context. Thirdly, it indicates challenges as regard which are the new BD and DA additional digital skills required for an MA that form the abstract system of knowledge that formalizes the new capabilities of MAs' job profile.

The remainder of this paper is as follows. Section 2 introduces BA management and analyzes topics' emergence in business, while Section 3 describes the study's methodology. Section 4 details the results, based on academic and professional literature. Section 5 discusses the results, while Section 6 outlines further research developments. Finally, Section 7 presents the conclusions of the paper.

2. Big Data and Data Analytics Emergence in Business

The abundance of new, innovative sources of information, together with the technological changes brought by digitalization in organizations, is changing the business model for large corporations, as well as for small and medium-sized companies (Möller et al. 2020).

It is impossible to discuss BD and DA without taking into consideration other emerging technologies such as Cloud Accounting, Blockchain, Robotic Process Automation, Artificial Intelligence and the Internet of Things, which together in their synergy are transforming the economy and industry (Hamilton 2021) and contributing to the redefinition and expansion of the role of accountants in general (Moll and Yigitbasioglu 2019). Thus, we use the broader term "technologies" or "digitalization" to discuss DB and DA concerning other interrelated technologies.

Internally, the more an organization uses digital technology, the more innovative data is generated that is available for further use. Besides, the developments in the management

of unstructured and semi-structured data allow organizations to make smarter use of a variety of historical and new data sources (i.e., CCTV, email and text, and pictures and voice) (Vasarhelyi et al. 2015; Warren et al. 2015; Appelbaum et al. 2017). By deploying a mix of structured and unstructured data, companies are able to gain further valuable insights than just by solely resorting to structured data (Richins et al. 2018).

Over the last 20 years, the need to process larger and larger structured and unstructured data-sets has changed the way data is collected and analyzed. Conventional database management systems and commonly used software tools cannot keep up with capturing, curating, handling and processing data within a tolerable amount of time. BD requires a series of technologies and techniques with a new form of integration to help reveal insights from these varied and complex data-sets (Bhimani and Willcocks 2014; Warren et al. 2015; Appelbaum et al. 2017; Ionescu 2019).

Given the background, BD can be described by a series of features—also known as BD's 4 V's, respectively, vast volume, wide variety, high velocity and indeterminate veracity (IBM 2012; Bhimani and Willcocks 2014; Appelbaum et al. 2017; Cavelius et al. 2020). *Volume* finds its correspondence in the quantity and size of generated and stored data that determines the value and potential insight highlighted by Andreassen (2020). *Variety* lies in the type and nature of data sources, with BD being either semi-structured or unstructured, or incongruent, non-uniform data of different sources, sizes, shapes and inbounding irregularly, apart from internal sources and apart from external sources (Vasarhelyi et al. 2015; Appelbaum et al. 2017). *Velocity* epitomizes that data input is continuous and usually has to be processed quite quickly to yield valuable results. It represents the speed of change at which data is generated and processed, with data being available in real-time, in correspondence to the frequency of generation, respectively, of handling, recording and publishing, as depicted by Kitchin and McArdle (2016). Finally, *veracity* embodies the truthfulness, certainty and reliability of the data; its quality; and its final value, respectively, and whether its accuracy can be relied upon. Other characteristics refer to the *exhaustiveness*, the ability to capture and record the entire system, with BD including (or not) all the available data from sources, *extensionality* showing the possibility of quickly adding and easily changing new fields in each element of the data collected, and *scalability* the BD storage system's ability to can expand rapidly (Kitchin and McArdle 2016).

Data Analytics (DA) supports effective, economic and efficient decision-making through analysis of the pre-established BD sets with the aid of different techniques and technologies (Bhimani and Willcocks 2014; ACCA 2016; Novak et al. 2021). DA includes a large variety of techniques as follows. *Data mining* analyzes data to detect patterns and substantiate relationships, i.e., associations, sequences and correlations. *Text or voice analysis* is scanning either text, i.e., emails and word processing documents, either audio files, to extract useful information. *Statistical analysis* is useful to identify trends, correlations and changes in behaviors (Runkler 2012), respectively, Descriptive, Diagnostic, Visual, Predictive and Prescriptive Analytics (Appelbaum et al. 2017; Nielsen 2018). In conclusion, BD relates to the nature of data (Arnaboldi et al. 2017b) and DA refers to tools used to collect and analyze BD; thus, we refer to 'BDA' to capture the relationship between the two terms. BDA refers to the whole process of *analyzing data using technologies* like Business Intelligence, Cloud Computing and databases, and *visualization* with charts, graphs and other displays of the data.

Recognizing the value of BDA to extract useful information (Warren et al. 2015; ACCA 2016), companies are starting to use BDA as an essential innovation that allows their executives' access to practical information, both structured and unstructured, related, for example, to market trends and customer behavior (Bhimani and Willcocks 2014). At the same time, companies must be aware of the big quantity of information provided by BDA as conducting (Quattrone 2016) or not (Spraakman et al. 2015) to data overload and bad decisions.

Previous studies have shown that managers play a crucial role in the whole process of digitalization, and their priority should regard maximizing their knowledge about innovative data sources (Vasarhelyi et al. 2015; Castellano et al. 2017; Cockcroft and Russell 2018). In this context, Quattrone (2016) argues that new, untraditional data sources provide information beyond what managers can genuinely apprehend and commendably use, but at the same time postulates that there might be too much data and it is sometimes hard to extract the essence (Quattrone 2016).

The rise of BD has an impact on management accounting and controls, information, and decision-making by undoubtedly reshaping the managerial reliance on traditional information (Appelbaum et al. 2017; Bredmar 2017; Drew 2018; Bhimani 2020). Management accounting is changing rapidly from simply reporting aggregated historical value to comprising organizational performance management and offering decision-related information to the management. Alongside BD's emergence is the shifting of MAs' role by changing their tasks and responsibilities (Dilla et al. 2010; IBM 2013; Bertsimas and Kallus 2020).

Video, audio and textual information have the potential to improve managerial accounting practices and conduct to effectively control systems and innovative processes as regard budgeting and to deliver valuable information for planning and decision-making as the dynamic, real-time global economy progresses (Vasarhelyi et al. 2015; Warren et al. 2015). Contrary, there are critics of BD's effects on management accounting, because BD may be increasing the complexity of cost structures (Bhimani and Willcocks 2014) or prompting decision-makers to make bad decisions faster (Quattrone 2016). All these aspects mentioned above are leading to myriad problems in regard to the redefinition and reshaping of MA's job profile, respectively, their novel tasks, responsibilities and new set of skills.

3. Materials and Methods

As the BD and DA subject is relatively new, our study provides a review of academics' and practitioners' publications with a specific focus on the influences of BD and DA on the MA's role in organizations and the enriched set of tasks, responsibilities and skills that might influence, in the near future, the MA's job description.

Concerning the academic studies, WOS, ProQuest, Scopus and Google Scholar databases were searched based on keywords containing the expression ("Innovative Data Sources" OR "Big Data" OR "Data Analytics") AND ("management accounting" OR "managerial accounting" OR "performance management" OR "cost management" OR "control" OR "budget" OR "planning") from business, economics and management domains, without a predefined search period. Due to the freshness of the topic, the sample includes all types of publications: articles, book chapters, conference proceedings and papers posted on SSRN. The duplicates were eliminated. After a double review of the publications' abstracts by both researchers, the studies without relevance to MAs' job role description were excluded, as exemplified by Luen et al. (2015), who focused on establishing a company BD maturity model, and Wongsim et al. (2019), who investigated the factors that affect a successful BDA implementation. In addition, Liu (2016) and Xu (2017) were eliminated as being too general or dealing tangentially with the topic or, for example, using an approach from the technology of information viewpoint.

The final sample of 45 scientific publications (marked with * in References) includes 36 articles, 7 conference proceedings and 2 book chapters, with relevant insights for our research objective. The publications are from the last ten years (2010–2020) (Dilla et al. 2010; Runkler 2012; Schläfke et al. 2013; Acito and Khatri 2014; Bhimani and Willcocks 2014), but after 2015 the interest revealed in the number of publications increased, so for each of the following years more than seven publications are represented in our sample. To check the selected sample's relevance, although the more recent publications are recent, we analyzed the citation number from Google Scholar.

In addition to academic studies, we considered relevant for our aim 16 professional publications (marked with ** in References) issued by IMA (Institute of Management

Accountants), ACCA (Association of Chartered Certified Accountants), CIMA (Chartered Institute of Management Accountants) and CGMA (Chartered Global Management Accountant), or published in professional journals *CPA Journal*, *Accountancy Journal* or *Strategic Finance* (Tables 1 and 2).

Table 1. Technical articles.

Issuers	Topic	Description
ACCA (2016, 2020a, 2020b, 2020c, 2020d, 2020e)	DA	Explaining the DA and the role of MA, providing different companies' perspectives and predictive tools and techniques
IMA (2013, 2019)	BD	Promoting new trainings for MA that develop DA skills
CGMA (2014)	BD	Revealing the impact of BD in business
CIMA (2016)	DA	Discussing the relation between BD and decision making and the role of humans in this equation
ICAEW (2019)	BD & DA	Overviewing the impact of BD &DA in the accountancy profession

Table 2. Articles in professional journals.

Issuers	Journals	Topic
Cokins (2013, 2014)	Strategic Finance	Description of top 7 trends in management accounting with emphasize on digital technologies BD and DA
Dinan (2015)	CPA Journal	Providing examples about how DA and predictive analytics can transform the MA's role in a one more proactive way
Lin (2016)	CPA Journal	Explaining why CPAs need to have knowledge in the area of Business Analytics
Drew (2018)	Journal of Accountancy	Developing a discussion regarding the future of accounting practice in the big data context

There publications were extracted as being mentioned in the scientific publications selected sample or by searching with the previous mentioned keywords on Google Academic platform.

There are three main issues tracked when reading the whole sample of (scientific and professional) publications: the risks, opportunities and challenges for MA in regard to the BD and DA.

The Results section is divided into four subsections. First, we briefly describe the sample of scientific publications used. The following three sections use both scientific and professional publications to highlight the risks, opportunities and challenges that MA professionals' practitioners face in the novel context of the disruptive BD and DA emergence in companies. The results identify the vicissitudes in the MA's role in organizations and the competition with other professions over the new fathomable problem of innovative sources of data. The results are followed by discussions and future developments from both a theoretical and practical perspective.

4. Results

4.1. Evolution of Debates Concerning BD and DA in the Area of MA

The interest in DA of management accounting researchers is in an emerging phase; for this reason, papers from 2010–2016 are mostly conceptual. Starting with 2017 research interest in empirical quantitative management accounting has increased considerably; thus,

case studies based on semi-structured interviews are revealing more as regard the MA perception about BD and DA (Arnaboldi et al. 2017b; Andreassen 2020; Bergmann et al. 2020). The general conclusion of the studies is that not enough is known about how MAs are using DA, specifically, what tools they utilize, what type of analysis is being performed and what skills and competencies are required. DA represents, undeniably, a relatively new responsibility for MAs.

The scientific publications analyzed are from accounting and management area scientific journals, with three dedicated issues in top journals *Accounting Horizons*, *Accounting, Auditing and Accountability Journal* and *Journal of Management Control*.

In 2015, Accounting Horizons launched, in volume 29 issue 2, a forum dedicated to BD's impact on accounting and audit. Griffin and Wright (2015), in the forum's opening, consider BD as one of the profession's most pressing and unyielding challenges (Griffin and Wright 2015). BD and DA allow companies to process a billion data elements daily to comprehend their competitive environment for significant decision-making and business strategies. BD and DA fundamentally change the way companies understand and report information. Vasarhelyi et al. (2015) draw an overall framework of BD in accounting and auditing, concentrating on sources, ranging from the ERP's structured data to unstructured and semi-structured information from the environment (Vasarhelyi et al. 2015). More focused on the MA interaction with innovative data sources are Warren et al. (2015), who consider that the use of BD conducts managerial accounting practices, improves and advances effective management control systems and budgeting practices, and, subsequently, provides useful information for decision-making as the dynamic, real-time global economy evolves (Warren et al. 2015). Schneider et al. (2015) also emphasize how BA fundamentally changed MAs' tasks, predominantly those that provide inference, prediction and assurance to decision-makers (Schneider et al. 2015). Krahel and Titera (2015) argue in the essay that a transformation in accounting and audit standards focusing on data, the innovative processes that generate them and their analysis, rather than their presentation, will add value and relevance to the accounting profession, empower end-users and increase the efficiency of the capital markets (Krahel and Titera 2015). Concerning the practitioners, Schmidt et al. (2020) investigate their resistance to move beyond Excel and Adopt New Data Analytics Technology (Schmidt et al. 2020).

Another Special Issue of the *Accounting, Auditing and Accountability Journal* (*AAAJ*) on Social Media and Big Data (see vol. 30, Issue 4, 2017) highlights some of the BD challenges for the accounting profession. Arnaboldi et al. (2017a) outline an agenda for those inspired to research the interplay between accounting and BD (Arnaboldi et al. 2017a), highlighting the implications of Predictive Analytics for organizational decision-making; how numbers, narratives and visuals can communicate significant data performance indicators; and the role of accountants inside organizations in using BD. Concerning the accountants' interaction with unstructured data, Arnaboldi et al. (2017a, 2017b) reveal the reluctance of accountants to see social media as a useful source of business development information (Arnaboldi et al. 2017a, 2017b).

Until now, only *Journal of Management Control* has issued a volume (April 2020) dedicated to DA and management accounting, and in the editorial, Möller et al. (2020) perceived a lack of empirical papers debating the effects of DA on the specific area of management accounting (Möller et al. 2020). Bhimani (2020) begins with a summary of digital data and management accounting, specifically, why a reconsideration of research methods is needed (Bhimani 2020). The papers' approaches in this volume have been influential in the field because they have targeted the outcome of digitalization on main controlling processes: budgeting and reporting (Bergmann et al. 2020), and on the overall control system (Vitale et al. 2020).

A qualitative methodology was considered most appropriate to reconnoiter the topic given the exploratory nature of the papers' research objectives. A set of conceptual papers debate the BD's impact on accounting (Bhimani and Willcocks 2014; Vasarhelyi et al. 2015; Warren et al. 2015; Quattrone 2016; Arnaboldi et al. 2017a; Richins et al. 2018) and how

BDA improve MA's tasks and techniques (Schneider et al. 2015; Appelbaum et al. 2017) or how to be researched (Bhimani 2020). Vasarhelyi et al. (2015) encapsulate the advancement of management accounting from paper-based aggregate information records via charts of account/general ledger into BD and DA and conceptualize the profession's future (Vasarhelyi et al. 2015). In the same light, Bhimani (2020) presents a synopsis of digital data and management accounting, asking why a reconsideration of research methods is required (Bhimani 2020). Nielsen (2018) proposes a framework for determining the influence of the operational activity on the use of management accounting for decision-making (Nielsen 2018), while Appelbaum et al. (2017) propose a Managerial Accounting Data Analytics (MADA) framework based on the balanced scorecard theory in a business intelligence context (Appelbaum et al. 2017). From the same angle, Richins et al. (2018) consider BD both an opportunity and a threat to the accounting profession (Richins et al. 2018) and develop a conceptual agenda based on the two types of data (structured vs. unstructured) and the two categories of analysis (problem-driven vs. exploratory). Arnaboldi et al. (2017a) explore the intercorrelation between technology-enabled networks—i.e., social media and BD—and the accounting function to stimulate research and debates on this topic (Arnaboldi et al. 2017a). Furthermore, Rikhardsson and Yigitbasioglu (2018) and, later on, Moll and Yigitbasioglu (2019) review top accounting and information systems journals, underline some of the research gaps and propose a framework for establishing a connection between digitalization and management accounting (Rikhardsson and Yigitbasioglu 2018; Moll and Yigitbasioglu 2019).

Alternatively, the case studies approach allows a better, more profound understanding of the analyzed phenomena inside the entities. Andreassen (2020) uses the case of a technology-oriented finance sector company to debate the role of how digital technologies are influencing the MA's role in the company (Andreassen 2020). Focused on the case of an SME, Vitale et al. (2020) investigate whether and how BD affects the MAs' tasks in management control and which drivers are involved in such interaction (Vitale et al. 2020). Heinzelmann (2018) uses a qualitative case study to express his viewpoint about the impact of IT systems on MAs' occupational identities (Heinzelmann 2018). Arnaboldi et al. (2017b) conducted research based on two organizations to analyze how social media is reshaping departments' relations (Arnaboldi et al. 2017b).

To apprehend in what way MAs' tasks are distressed by DA, in the inductive practice-oriented papers, Spraakman et al. (2015), Cavelius et al. (2020) and Schmidt et al. (2020) conducted interviews with MAs to gather evidence concerning the impact of BDA on the accounting profession and MAs tasks or the resistance to emerging DA technology (Spraakman et al. 2015; Cavelius et al. 2020; Schmidt et al. 2020). Heinzelmann (2018) interviewed accounting professionals, controllers and managers about IT systems' effects on MAs' work within organizations (Heinzelmann 2018).

Bergmann et al. (2020) employed a quantitative methodology, which prescribes the use of surveys to investigate the factors that determine the use of BA in the budgeting process and its effect on satisfaction with the whole process (Bergmann et al. 2020). A more comprehensive description is in another piece of research, where Vitale et al. (2020) empirically analyzed the BD impact on the SME's management control (Vitale et al. 2020). Schneider et al. (2015) scrutinized three clusters of features relating to DA, namely, design process, contingency and task performance (Schneider et al. 2015).

In the light of the reported findings, it is conceivable that the unknowns are extensive when reflecting on what MAs need to discern in regard to DA. In this sense, Arnaboldi et al. (2017b) conducted semi-structured interviews with social media managers, department managers, analysts, financial controllers and senior executives (Arnaboldi et al. 2017b). Oesterreich et al. (2019) used a text analytics methodology to determine patterns of Business Analytics competencies (Appelbaum et al. 2017) and information technology skills (Oesterreich et al. 2019) for the controlling and management accounting profession.

Based on the review of the scientific articles, in the next section are summarized the main issues concerning the transformation of MA's professional practice and knowledge because of the emerging new innovative sources of data.

4.2. Risks Concerning the Professional Interference in the Arena of BD and DA

Accountants are not the only professionals who could take on a more prominent role in dealing with data across organizations. Marketing or operations specialists in sundry organizations are starting to use BD and may undertake a more leading role than finance. Naturally, data science and IT functions also have a decisive part to play concerning data (Heinzelmann 2018). All of the professions mentioned above are entering the expansive category of emerging information professions (Vasarhelyi et al. 2015; Furness 2019; Moll and Yigitbasioglu 2019; Wongsim et al. 2019) and might have or inquire about a role in the area of innovative data sources. Besides, any reluctance or failure of the profession to pursue new advances in data leaves open the likelihood of MAs being marginalized in regard to decision-making, with data scientists, for instance, playing a more significant role (ICAEW 2019; Moll and Yigitbasioglu 2019; Möller et al. 2020).

In the information field, there is a tension between professions (Abbott 1988); the profession's jurisdictions are continually evolving and increasingly becoming weakly delineated (Furness 2019) in handling and analyzing data. BD and DA increase the competition between the professions connected with data and information and act to weaken an existing profession's jurisdiction or create an entirely new niche, as with the proliferation of computers and technologies (Furness 2019). Because of the competition, maybe one profession will take over another profession's attributes or several negotiated symbiosis forms (Abbott 1988). Additionally, concerning MA, digitalization sparks tensions on the role and main challenges of MA in the digital era: the tensions on the centrality, authority and power of the MA function (i.e., the influence on decision-making processes) (Andreassen 2020; Cavelius et al. 2020; Möller et al. 2020).

Within the system, professions are frequently in flux, wherein the boundaries between occupations are continually negotiated and contested. The professions are always vulnerable to changes in the objective character of their central tasks, and technology has the ability to divide tasks and regroup them (Furness 2019). Many professions claim the "new territory" of BD and DA and react differently, including amalgamation or horizontal or vertical division (Abbott 1988).

Some authors consider that BD and DA will have positive implications for extending access to different data types for the accounting profession and extending MAs' expertise (Warren et al. 2015). Others, on the contrary, suggest that they seem to be backstage, while other actors, namely, digital officers or marketing and communication managers, have crossed over to performance measurement (Arnaboldi et al. 2017b).

Others consider that BD and DA are blurring professional boundaries (Cockcroft and Russell 2018), which might create some tensions and pressures between them. For this reason, our study finds and describes competition over jurisdiction between MAs and other groups of employees, i.e., engineers' expert knowledge, sales and customer relations department (Andreassen 2020), IT personnel (Heinzelmann 2018) and marketing department (Arnaboldi et al. 2017b).

BD and DA context implies new roles: "Data Scientist" for Data Analytics, "Data Manager" for data management, "Data Champion" for data culture and "Business Partner" for value creation (Bhimani and Willcocks 2014; CGMA 2014; Brands and Holtzblatt 2015; ACCA 2016; Oesterreich et al. 2019); a representative illustration of the roles is presented below (Figure 1). Therefore, the MA's role is anticipated to move towards a "Data Scientist" with robust systematic and mathematical-statistical abilities, as well as Business Analytics capabilities (Lin 2016; Appelbaum et al. 2017; Oesterreich et al. 2019).

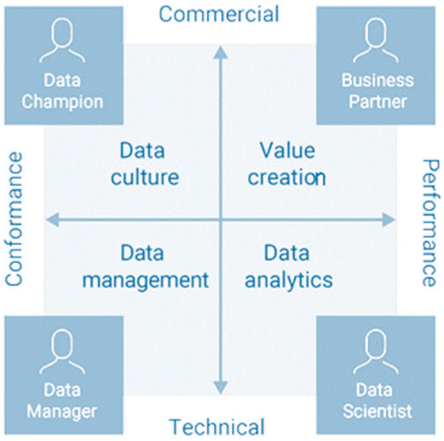

Figure 1. Possible roles in the era of Big Data and Business Analytics (CGMA 2014).

MAs might take on data management/governance (Bhimani and Willcocks 2014). Information systems or IT departments have traditionally managed this role. A critical feature of handling BD is the design of periodic and ad-hoc dashboards, reports and scorecards, to assess performance (Cockcroft and Russell 2018). Besides, the MA is well-positioned to exploit BD for fraud and risk management, data visualization, auditing and performance measurement (Cockcroft and Russell 2018). MAs already excel at the problem-driven analysis of structured data. Moreover, they are well-placed to play a key role in the problem-driven analysis of unstructured data (Bhimani and Willcocks 2014). They can back-up data scientists performing exploratory analysis on BD because MAs are acquainted with structured data-sets, enabling the transition to working with unstructured data. They possess knowledge of business essentials.

The challenge is immense and requires new knowledge in technical and programming areas of expertise. As leaders in the financial planning and analysis field, BD is part of a digital technology wave that can threaten many highly-skilled roles (Cockcroft and Russell 2018). Some MAs might see a way to enrich their skills, but for sure, others will prefer to stay in the "Business Partner" role and contribute to value creation only in the traditional manner (Rikhardsson and Yigitbasioglu 2018). While some consider that MAs only have to understand the unlocked potential of BD and DA and do not have to get specific technical expertise (Bhimani and Willcocks 2014), others have a different view and foresee a paradigm shift for BD, where MAs will need to develop and acquire skills to be able to further support the decision-making process (Rikhardsson and Yigitbasioglu 2018).

Acknowledging the four roles presented in Figure 1 creates some concerns about the potential "de-professionalization" or a vertical division effect (Abbott 1988) of greatly technically oriented work environments that have already been enunciated in the professionalization specialty literature (Quattrone 2016; Richins et al. 2018). Abbott (1988), for instance, highlighted how the dependence of mathematical techniques possibly weakens professional systems of knowledge and shrinks the image that professionals construct for themselves for the reason that it is grounded predominantly on their expert knowledge around which professionals build their jurisdictional authority legitimacy and public image (Abbott 1988). The function of management accounting might become integrated into a broader analytical function in the organization, together with Customer Analytics, Process Analytics and Environmental Analytics (Rikhardsson and Yigitbasioglu 2018).

Following the Abbott (1988) vertical division idea (Abbott 1988), but from a profession inside the internal stratification perspective, Andreassen (2020) considers that BD and DA can transition to narrower and more specialized roles (Andreassen 2020). Considering a large group of companies, the researchers describe a swing for divisional MAs towards narrower roles in their tasks and expectations. In contrast, at the group level, a business-oriented role entails expanding task expectations. Consequently, BD and DA conduct a vertical division of the MA profession, as Abbott (1988) considers, in the case of corporations

(Abbott 1988). As a result, MAs are split into two divergent categories facing different expectations: divisional and group level MAs (Abbott 1988).

As part of a challenged profession, MAs can respond not only by fighting to gain a new area or change its level of abstraction but also by changing internally. Other possible effects of BD and DA over the profession might be amalgamating financial accounting with managerial accounting roles in organizations. By understanding the background of BD, more and more modern organizations have progressively understood the prominence of BD. In the process of financial management, financial accounting has slowly but surely shifted to management accounting (Meng 2018). This transformation reflects an unavoidable trend when financial accounting performs its duties and obligations, but it still needs IT's help. Simultaneously, against this backdrop, a systematic management model can be created and put into practice. Financial and accounting workforces might combine unswervingly and effectively strategic and systematic enterprise management thinking, understanding and recognizing enterprise value (Meng 2018).

Whether BD and DA become a part of the MAs' jurisdiction is hard to predict because it involves a delicate yet tantalizing balance amongst related jobs. The roles of "Data Scientist", "Data Manager" and "Data Champion" are highly specialized (ACCA 2016). Respectively, they represent technical areas that imply statistical, Data Analytics, programming and communication (ACCA 2016; Cockcroft and Russell 2018) that may not be necessary for the management accounting zone.

Nonetheless, what is sure is the support of accountancy professional organizations to prepare MAs for these new areas, providing abstract knowledge and credential-certifying expertise in the BDA area (Arnaboldi et al. 2017b; ICAEW 2019).

Professional associations such as CIMA (the Chartered Institute of Management Accountants) (CIMA 2016) and professional accounting associations and bodies across Europe and America are continually asking for a role in the BD domain (IMA 2013, 2019; CGMA 2014; ICAEW 2019). Thus, new domains emerge, as BDA creates opportunities for professionals to undergo professional growth by understanding these developments (Abbott 1988).

Moreover, to ensure that their domain-specific knowledge or expertise stays current in light of environmental changes, the national professional accountancy professional organizations implemented BDA training in their continuing education (i.e., CPE courses) (ICAEW 2019). Changing socio-environmental factors require professionals to permanent "reeducate" themselves in response to even incremental developments (Abbott 1988). Accordingly, this continuous education requires professionals' ongoing effort to ensure that their domain-specific knowledge remains up-to-date.

Another essential factor that will influence this is the market and companies' requirements for MAs. Employers expect MAs to champion evidence-based decision-making, converting analytical insights into commercial insights and making sure these are used for improving business prospects and performance (Oesterreich et al. 2019). This status means that MAs' most significant opportunity is to use their combination of accounting and analysis skills with business understanding as business partners (CIMA 2016; Oesterreich et al. 2019; ACCA 2020c).

DA and BD will inevitably change MAs' roles, allowing them to direct their attention toward prospects of providing added value to a company and its clients (Richins et al. 2018). However, at the same time, with the emergence of BD, MAs will face the problem of information storage space; information security; and other issues concerning data veracity (Bhimani and Willcocks 2014), loss of data sovereignty, and loss and theft of data (Wang and Song 2016).

For all of these reasons, we consider inter-professional collaboration and collaborative learning as the key solution in this stage of the BD and DA knowledge and advance. The term "collaboration" expresses the idea of sharing and suggests a synergic and collective action-oriented toward a common goal in a spirit of harmony and trust. New teams of professionals need to mediate their collaboration at their professions' boundaries, recogniz-

ing as the boundaries space and boundary zones. The interaction between professionals with different backgrounds implies the same joint goals in working together. The growing use of interdisciplinary groups extends expectations to business-oriented roles, connecting technology progress to business practices and analyzing information. As difficulties and hitches arise, MAs can employ their business knowledge to integrate structured and unstructured data into analyses. In a collaborative team, MAs can cooperate with data scientists by endorsing content to explore, and then by interpreting the outcomes in light of strategic goals (Richins et al. 2018). In that connection, Arnaboldi et al. (2017b) highlight a change in the relationships and interactions between professions and organizational concerns regarding governance and control (Arnaboldi et al. 2017b).

Briefly, the BD and DA are now in the diagnosis stage in terms of the MAs' professional domain. If the BD and DA are "treated" using the available toolkit of the MAs' profession, and MAs will be proactive to gain expertise and abstract knowledge in this area, then this topic will become under the MAs' professional jurisdiction (Arnaboldi et al. 2017b). Alternatively, perchance we will witness a hybridization of professions (Arnaboldi et al. 2017a; IMA 2019; ACCA 2020a, 2020e), and the professional identity will disappear in the future digitalized era (Heinzelmann 2018), enabling the emergence of new professions or career patterns (Arnaboldi et al. 2017b; Oesterreich et al. 2019) as a result of the interrelation, interaction or reaction of professions.

4.3. MAs New Privileged Position Concerning BD and DA—Opportunities

The accounting profession is embracing new information sources and digital technologies (Moll and Yigitbasioglu 2019; Schmidt et al. 2020) in its attempt to be promoted from a technician role to a "Business Partner" role (Cockcroft and Russell 2018). BD and DA offer to MAs the prospect of shifting to a strategic, proactive future-oriented role in business (Warren et al. 2015; Nielsen 2018; ACCA 2020a, 2020e) with both benefits and risks. The shifting from heavily investing in data-collection and reliability missions leaves less time for advising managers and challenges operational business units to master BD and digital analysis tools (Cavelius et al. 2020). In this way, MAs might play an active role in their companies' digital transformation by adding value to the emerging mass of data (by making sense of that data, reflecting on business opportunities and challenging operational units and top-management with their expert knowledge). MA tasks are grounded in data; thus, data provide accountants with an opportunity to revolutionize their role into a much broader guardianship of data across their respective organizations (Bhimani 2020).

The configuration, discipline and ethical approach of the MA profession translates into the fact that the function is well placed to aid organizations to effectively use BD and advanced analytics. Furthermore, accountants' inherent prudence and skepticism can ensure BD's full and appropriate use (ICAEW 2019). Exploring this perspective, Rikhardsson and Yigitbasioglu (2018) propose a framework for studying the relationship between management accounting and Business Intelligence and DA technologies (Rikhardsson and Yigitbasioglu 2018). Since this is new territory, Bhimani and Willcocks (2014) caution concerning the real advantages and risks of reorienting accounting and finance functions to harness BD's potential (Bhimani and Willcocks 2014), revealing several gaps and shortcomings since there should be a clear delineation of information systems that provide these established accounting and finance capabilities (Cockcroft and Russell 2018).

MA is concerned with cost management, planning, management, operational control, performance measurement, and decision-making (Brands and Holtzblatt 2015). With innovative data sources and DA, the scope of MA is enlarged, based more actively on real-time data that add a predictive capacity (Cokins 2013), useful for strategy formulation, implementation and monitoring (Richins et al. 2018). The emergence of BD and DA in MA might trigger changes causing issues in cost structures (Acito and Khatri 2014), and information excess, and cause the making of incorrect decisions at a faster pace (Quattrone 2016). Additionally, costing architectures have altered due to the evolution of the links between information, data and knowledge (Bhimani and Willcocks 2014; Schneider et al.

2015; Warren et al. 2015; Arnaboldi et al. 2017b; Richins et al. 2018; Rikhardsson and Yigitbasioglu 2018).

In the management control field of study, BD's use can induce significant managerial changes (Bredmar 2017; Rikhardsson and Yigitbasioglu 2018; Möller et al. 2020). The literature debates concerning the opportunities and real benefits is in an emerging phase (Vitale et al. 2020), with several questions remaining to be addressed. By tradition, the processes of decision-making are being supported by the management control systems that use historical and cumulative data (Gärtner and Hiebl 2018), with a limited future-oriented view. Nevertheless, to reach efficiency, economy and effectiveness, management control needs real-time data (Rikhardsson and Yigitbasioglu 2018). BD has this role, and therefore can greatly impact the management control systems.

Moreover, Warren et al. (2015) posit that BD will assist the development and evolution of effective management control systems and budgeting practices (Warren et al. 2015). Since budgeting involves a routine procedure, it could integrate digitization's effects comparatively quickly into companies' budgeting processes. Budgeting will imply more than the traditional spreadsheet where the sales numbers received from other departments are transposed (Warren et al. 2015).

Instead, MA might work diligently with the top managers for adding unquestionably more relevance to previsions considering the innovative mix of both external and internal sources of existing data and records (Cokins 2013; Bredmar 2017). MAs should use the synergy of their powerful management accounting abilities and make good use of their management accounting tools to translate the existing records and data into predictive insights (Bergmann et al. 2020). In this way, MA can definitively contribute to an organization's strategic direction (Warren et al. 2015). Hereafter, together with an AI perspective, DA will make performance management more dynamic and customized.

Furthermore, analytic and data visualization software allow MAs to provide strategic decision support. Many other value-adding opportunities could arise for MAs in this area. Against this backdrop, Bergmann et al. (2020) highlight Business Analytics' role in enhancing the relationship between planning, function and budgeting (Appelbaum et al. 2017; Bergmann et al. 2020). Thus, DA and DA's use allows an increased budget function for organizations interested in planning, forecasting, coordination and resource allocation (Bergmann et al. 2020).

For financial reporting purposes, the most suitable category of DA is Descriptive Analytics, since it summarizes and describes a business's financial situation. However, in the field of performance measurement (Schläfke et al. 2013; Nielsen 2018) and controlling (Oesterreich et al. 2019), MAs can use Predictive Analytics, which can implement inputs from Descriptive Analytics with Machine Learning algorithms, to deliver a forecast of future organizational performance. By using outcomes from performance measurement and cost accounting, Prescriptive Analytics are assimilated into planning and decision-making to offer evidence regarding the optimized solution.

BD comprises both external and internal data. External data is data gathered outside the company (i.e., news, social media or the Internet of Things). Habitually, external data are unstructured data that can only provide information after being processed by analytics tools (Appelbaum et al. 2017). Conversely, internal data embodies data collected from sources inside the entity (i.e., the company's database), which is usually structured and familiar to MAs.

The era before digitization restricted accounting's access to organizational data, especially to financial data, and limited MAs in their use of existing management accounting techniques and tools.

The status of MA is changing now. Innovative sources of information present a first-hand prospect for MAs to play a dynamic role in data creation and decision support (Schläfke et al. 2013; Spraakman et al. 2015; Cavelius et al. 2020; Korhonen et al. 2020; Knudsen 2020; Vitale et al. 2020).

One of the first to highlight the challenge of non-traditional sources of data's incorporation into accounting was Vasarhelyi et al. (2015). From this standpoint, MA's tasks may include collecting and handling new unstructured sources of information (Vasarhelyi et al. 2015), managing the interaction between traditional, structured data and the new data while also integrating the latter (Richins et al. 2018). In this sense, MAs need to acknowledge the content of large unstructured data-sets collected from untraditional sources (i.e., emails, audio and video files, internet click streams, social media, news media, etc.). Secondly, they have to take into consideration all its characteristics: immense volume, high velocity, wide variety and uncertain veracity. Not least, MAs need to comprehend that all the data need to be of high-quality—respectively, complete, valid, accurate, precise, consistent, relevant and timely (Appelbaum et al. 2017).

Therefore, MAs' biggest BA challenge is to pass from exclusive structured data to a mix composed of structured, unstructured and semi-structured data. While structured data refers to data stereotypically spawned through the company's transaction processing systems, unstructured data originate from a wide variety of sources and may be in numerous forms (i.e., text, audio and video) (Vasarhelyi et al. 2015). Structured data are organized so that they can effortlessly be encompassed in a traditional relational database. Contrariwise, unstructured data, which embody the most considerable share of actual data, refers to data that lack structured data's organizational rigor (Bhimani and Willcocks 2014; Vasarhelyi et al. 2015; Richins et al. 2018).

In this context, extrapolating ample information unused in the past because it was not connected to an economic transaction can provide further insight into customers' preferences and how purchase decisions are made.

Hence, MAs should provide a joint framework for handling this information to extract meaning and create structured data about the data. Software that makes machine-processable structures exploits the linguistic, auditory and visual systems inherent in all forms of human communication. Algorithms can infer this inherent structure from the text, for example, by scrutinizing sentence syntax, word morphology and other patterns, either on small scale or on large scale (Richins et al. 2018). In this spirit, some researchers have suggested that unstructured information can then be deepened and tagged to address ambiguities and relevancy-based methods used to enable search and discovery (Bhimani and Willcocks 2014; Vasarhelyi et al. 2015; Richins et al. 2018).

Henceforth, MAs might have to rethink the way the information is gathered and processed; particularly, how they can capture and use real-time data and entire data-sets (Bhimani and Willcocks 2014; Korhonen et al. 2020). Conversely, the danger arises that MAs get locked into technical tasks such as data collecting and processing instead of becoming more involved in managerial decision-making processes (Schläfke et al. 2013; Zhou and Xia 2018). Nevertheless, we observe that MAs, once they have mastered BD and new tools, can become actively involved in their companies' digital transformation. As such, several researchers have recognized that they can add value to the emerging mass of data by making sense of that data, reflecting on business opportunities and challenging operational units and managers with their expert knowledge (Griffin and Wright 2015; Moll and Yigitbasioglu 2019; Andreassen 2020; Cavelius et al. 2020; Korhonen et al. 2020).

In this framework, Brands and Holtzblatt (2015) debate and analyze how MAs can place themselves to play a critical role in implementing and applying Business Analytics within their organizations (Brands and Holtzblatt 2015) as they move beyond traditional, transaction-based accounting to analytics. This trend will transform the way MAs' analyze and interpret data for their organizations in the future, not only concerning financial accounting (e.g., accounts receivable and payment monitoring) and especially regarding the visualization of data.

In conclusion, due to the MA function's unique position, MAs are the best placed within an organization to manage BD/DA organizations (Bhimani and Willcocks 2014) because there is already existing general professional trust in accountants.

4.4. Challenges to Adapt the MA's Skills to the New Tasks and Responsibilities Regarding BD and DA

To investigate the relationship between a profession and its work is no simple task. To be sure, professions' tasks have foreordained objective qualities that resist professions' efforts to redefine them. However, numerous elementary qualities of tasks turn out to be subjective qualities assigned by the profession with current jurisdiction. These objective and subjective properties have a dynamic and synergic liaison in which neither one prevails.

According to Abbott (1988), by using knowledge, a profession solves novel problems and adapts its practices to new niches by expanding its cognitive domain (Abbott 1988). Thus, by using its knowledge, the profession extends its capabilities in new areas and defines them as its proper work. Nowadays, in conjunction with the extensive use of emerging technologies, the MA's role in the company in general, and the MA's tasks in particular, have become more significant and, as a result, the MA profession may take the opportunity to extend its capabilities in the BD and DA areas. MAs must link theory and already existing concepts and knowledge to real-world application, in the context of digitalization (Richins et al. 2018; Schmidt et al. 2020). Being equipped with new tools and innovative processes enables MAs to build value in companies (Dilla et al. 2010; IBM 2013; Griffin and Wright 2015; Krahel and Titera 2015; Drew 2018; Knudsen 2020). Instead of being limited to routine spreadsheet analysis tools, it will transform management accounting analysis into more strategic decision support.

The following challenges related to BD and DA that influence the enhanced MA job description in a digital environment are related to new skills concerning the management and governance of traditional and innovative sources of information, and techniques to analyze the mix of data, business analytics process, and function structure (Appelbaum et al. 2017).

BD will have gradually important accounting implications, even as new types of data become accessible (Warren et al. 2015). As a part of the massive surge of digital technology, BD has the potential to endanger some highly skilled roles but, at the same time, open new career challenges in the analytics field (IMA 2013; Bhimani and Willcocks 2014). This is due to the elimination of distance between analysis and execution in organizations adopting BD technologies (Appelbaum et al. 2017).

A profession's ability to withstand its jurisdictions lies largely in the influence, authority and prestige of its academic, abstract knowledge (Abbott 1988). In academia, there is general agreement concerning the call to the accountancy profession regarding gaining a new set of skills in technologies and digitalization that will enhance the accountant's role in the business (Griffin and Wright 2015; Vasarhelyi et al. 2015; Lin 2016; Drew 2018). MAs' know-how in collecting, integrating and inferring data from manifold sources is expected to make them even more valuable with BD and DA's emergence (Richins et al. 2018).

Business Analytics (BA) and Information Technology (IT) skills have gained prominence as two major skill areas of the MA's job profile, becoming mandatory capabilities for this profession (Bhimani and Willcocks 2014; Appelbaum et al. 2017). However, the practitioners' community seems not to be prepared since many were slow to leave behind the traditional manner of performing their tasks, showing some unwillingness to move from looking backward to looking forward (ACCA 2020b, 2020d). The current competence profiles (e.g., controller/management accountant) do not comply with the recent requirements regarding Business Analytics competencies (IMA 2019). At least in the German-speaking area, according to Oesterreich et al. (2019), competencies in Business Analytics and IT professionals do not supply skills because they are not included in their web profiles on a business social network (Oesterreich et al. 2019).

Business strategy and understanding of business models and the accountant's role in business and Information Systems regard the development of a new generation of information technology that changes the traditional business model and resource integration model while also expanding the scope of service of management accounting to a certain extent, so that the MAs' work is extended from the enterprise internal management to the whole value chain

management, from the tactical level to strategic layer and from profit maximization to the sustainable value realization of the enterprise; it involves effective use of IT, design systems structure and data warehouses, and the evaluation, recommendation and implementation of the apposite ERP system (Bhimani and Willcocks 2014; Wang and Song 2016; Heinzelmann 2018). Schneider et al. (2015) consider that MAs can leverage existing technologies to scrutinize information (Schneider et al. 2015). They succeed in combining collecting and storing operational data in enterprise information systems and/or data warehouses with analytical tools to put forward multifarious information to decision-makers.

Data Governance encompasses the ability of managing, generating and storing large amounts of structured, semi-structured and unstructured data (Bhimani and Willcocks 2014; Appelbaum et al. 2017) by using adequate tools (i.e., SQL, Hadoop, MongoDB, R, and SAS) and the capability of designing and implementing systems to warrant the availability, utility, integrity and security of data (Gärtner and Hiebl 2018; Oesterreich et al. 2019). In the context of rapid digitalization, the spread of BD is shifting MAs' tasks, respectively, changing their techniques and analyses used to mix sources of information (Knudsen 2020).

Data Analytics skills lie in the ability of making use (by processing, verifying and analyzing) of quantitative and qualitative techniques (Bhimani and Willcocks 2014; ACCA 2016; Appelbaum et al. 2017), such as multiple queries, scripted or interpreted languages (i.e., SQL, Python, R), and advanced statistical tools for exploratory data analysis (i.e., cluster analysis, time-series analysis and Monte Carlo analysis) for the development of predictive models, through data mining, in order to identify patterns, relationships and text and voice analytics (Bhimani and Willcocks 2014; Oesterreich et al. 2019). Exploiting BD entails a blend of skills and abilities spread across three wide-ranging areas: statistical skills, to construct the algorithms and apprehend the robustness of models; data and technology skills, to excerpt and deploy data; and domain knowledge, to make the right inquiries and gain insights from analysis (Brands and Holtzblatt 2015; Richins et al. 2018). In this framework, DA provides MAs with the tools to scrutinize data from three different perspectives: inference, prediction and assurance. While inferring is enhanced by improving the revelation of operational efficiencies and augmenting decision support by compliance, regulatory reporting, narrative reporting and activity-based costing, predictive power is boosted by improving the process of spotting new products, as well as segment trends (Schneider et al. 2015; Appelbaum et al. 2017; Oesterreich et al. 2019). Respectively, assurance is enriched through a more remarkable capability of identifying performance gaps (Schneider et al. 2015). Currently, Excel and Access are most commonly utilized to execute a wide variety of DA activities, from simple descriptive reporting to more advanced data modeling, trend analysis and forecasting (Luen et al. 2015; Appelbaum et al. 2017; Richins et al. 2018; Rikhardsson and Yigitbasioglu 2018; Schmidt et al. 2020).

Finally, data visualization embodies the ability of envisioning data adequately and effectively interpreting and communicating the results of multifarious analyses for decision-making. Reporting and communication have always been important focuses for MAs and are seen as business language (Bhimani and Willcocks 2014; Gärtner and Hiebl 2018; Bhimani 2020). Other Business Intelligence tools and further sophisticated techniques are used in the third and fourth stages—Visual Analytics and Predictive Analytics (i.e., IMB's Cognos Analytics, SAP's Business Objects or Visualization Tableau), as outlined by several researchers (Luen et al. 2015; Appelbaum et al. 2017; Rikhardsson and Yigitbasioglu 2018).

Consequently, MA's tasks refer to different types of analysis presented below in a bottom-up approach in terms of difficulty and value added by each of them, from descriptive level (the lowest) to the prescriptive level (the highest), including all MA functions: cost control, budgeting, performance management, planning and forecasting (Acito and Khatri 2014; Krahel and Titera 2015; Warren et al. 2015; Arnaboldi et al. 2017b; Bergmann et al. 2020). As possible applications, Brands and Holtzblatt (2015) have suggested that DA can be used internally in different analyses (i.e., sales, accounts receivable and credit, accounts payable and payment monitoring), as well as in due diligence with mergers and acquisitions and forensic accounting (Brands and Holtzblatt 2015). The novelty bought by the

innovative sources of information is reflected in the highest type of analyses (prescriptive) performed by an MA (Appelbaum et al. 2017; Nielsen 2018).

Accordingly, with BD mined from both internal and external data sources, MAs could now employ BD and DA techniques to offer hindsight—Descriptive Analytics and Diagnostic Analytics, respectively, to offer foresight into Predictive Analytics and Prescriptive Analytics (Appelbaum et al. 2017; Nielsen 2018). In addition, Visual Analytics offers insight by enhancing rapid decision in real-time (Figure 2).

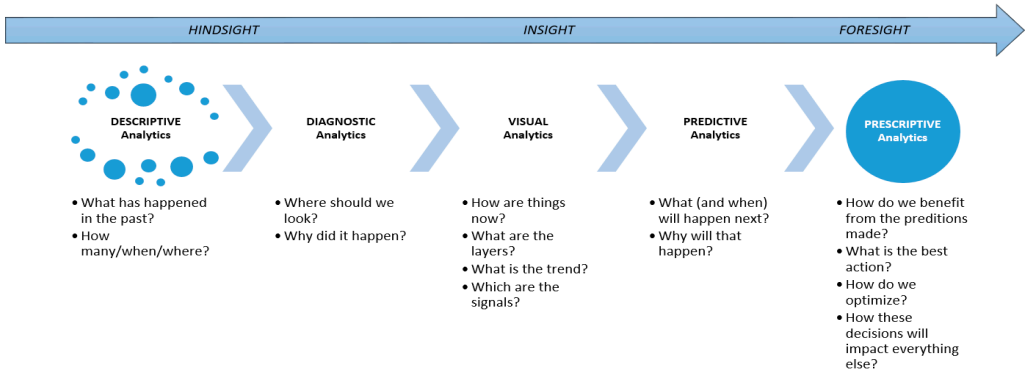

Figure 2. MAs' tasks in the era of Big Data and Business Analytics.

Descriptive Analytics presents what happened, when it happened and where it happened, with the aid of descriptive statistics, dashboards and other visual forms (IBM 2013; Appelbaum et al. 2017). Tools and techniques that the MA uses are: ratio analysis, text mining models, reporting, data mining and data aggregation (Xu 2017; Zhou and Xia 2018).

Diagnostic Analytics reveals the motives underlying the events that took place, respectively, other areas for further investigations. MAs might use the following procedures: discovery and alerts, query and drill-downs, clustering models, process mining, rank correlation measurement, what–if analysis and root cause analysis (Spraakman et al. 2015; Bergmann et al. 2020). Output data (i.e., ad-hoc reports) may include not standardized analysis, comprising more detailed information than the current standardized one, especially concerning specific issues. These reports still represent a snapshot of the past, with MAs having limited ability in guiding decisions. However, MAs need to develop new reports on Key Performance Indicators and adequate scorecards, and flexible steering approaches, such as the Objective and Key Results system (Spraakman et al. 2015; Bergmann et al. 2020).

Visual Analytics enables gaining insights into the data both from the past and present in real-time. Data visualization will change the way MAs work with data. Expectation will be for them to be able to respond to issues faster while also be able to dig for more insights by looking at data differently and with more imagination (Cockcroft and Russell 2018; Nielsen 2018). While visualization is at the center of Business Analytics, MAs are in the data explosion center (Warren et al. 2015; Bergmann et al. 2020; Cavelius et al. 2020). They are poised to become ever more vital to stakeholders in enabling data and insight-driven organizations (Figure 3).

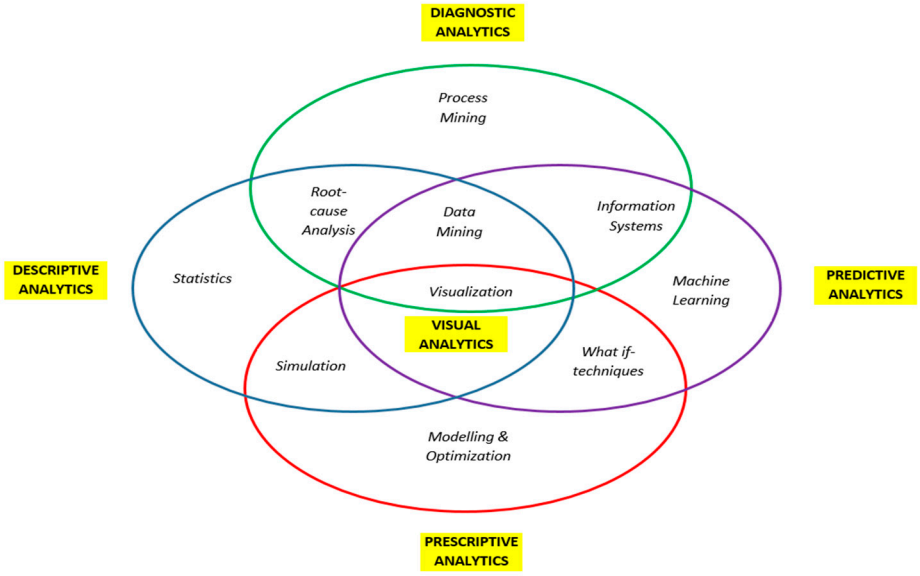

Figure 3. The confluence and radial layout of Visual Analytics in the context of BA and MA's tasks and techniques (adapted after Nielsen 2018).

MAs will need to learn how to use data visualization tools to analyze data, gain new insights from visual analytics and communicate those insights effectively by identifying irregular and potentially fraudulent accounts payable transactions (Cockcroft and Russell 2018)—hence the need for automated and dynamic reporting to be made available, allowing one to make use of intelligent dashboards that consider data visualization methods that are engaging for the audience (Warren et al. 2015; Bergmann et al. 2020; Cavelius et al. 2020).

Predictive Analytics aims to uncover certain patterns and certain relationships between data, therefore helping to answer the question of what might happen (Appelbaum et al. 2017; Cockcroft and Russell 2018; Nielsen 2018), specifically, when and why. As depicted by Vasarhelyi et al. (2015), Zhou and Xia (2018) and Wongsim et al. (2019), methods used by MAs typically cover predictive modeling techniques, statistical modeling techniques (i.e., regression, factor analysis and clustering), causal forecasting techniques and ML techniques (i.e., neural networks) (Vasarhelyi et al. 2015; Zhou and Xia 2018; Wongsim et al. 2019; Bertsimas and Kallus 2020). Predictive Analytics compared with others is a proactive focus on forecasting (Dinan 2015), while the latter two mainly focus on the analysis and reporting of historical data (Bergmann et al. 2020). To conclude, Predictive Analytics makes use of inductive logic rather than deductive logic (Spraakman et al. 2015), enabling MAs to determine trends in relationships between variables, ascertain the strength of their correlation and hypothesize causality. MAs usually use Predictive Analytics techniques to make an educated guess at likely results (a guess at the future), thus permitting them to help inform low-complexity decisions regarding predicting the future progression of events and taking necessary actions (Cockcroft and Russell 2018). An example of forecasting and trend analysis lies in budget projection or planning, respectively, in identifying patterns (that have changed) in trends by expenditure (Spraakman et al. 2015).

Prescriptive Analytics refers to ways of benefiting from predictions that have already been made, and the best course of action, specifically, the impact of a decision on everything else (Dinan 2015; Appelbaum et al. 2017; Nielsen 2018; Bertsimas and Kallus 2020). These encapsulate what MAs should do following an optimizing approach, its main objectives being optimization, simulation and actionable information, for critical, complex or time-sensitive decision-making (Dinan 2015; Coyne et al. 2018; Nielsen 2018). Prescriptive Analytics is the process of collecting BD and using them. Thus, for the MAs job profile, mastering tasks related to prescriptive analysis represents a new achievement for the profession, Cokins (2014) mentioned "predictive accounting" as a trend area for management accounting (Cokins 2014), together with BA embedded in ERP systems (Vasarhelyi et al. 2015;

Heinzelmann 2018). In this instance, MA uses techniques such as stochastic techniques, heuristics procedures, optimization, random testing, simulation algorithms, streamlining, Game Theory, decision analysis and rule-based systems (Appelbaum et al. 2017; Nielsen 2018) to advise on possible outcomes, recommend numerous possible solutions to a problem and lead one to consider the best possible course of action (Appelbaum et al. 2017; Nielsen 2018).

The step from the Predictive to Prescriptive approach is significant. Whereas Predictive Analytics and, implicitly, statistical modeling of scenarios is more about measuring correlation to test a hypothesis (Spraakman et al. 2015), ML is about predicting outcomes founded on several variables. BD, staggeringly large sets of information often reflecting crowd behavior and sourced from outside the company in question, is essential to ML (Dilla et al. 2010). It is intricate enough to improve AI's decisions over time (Moll and Yigitbasioglu 2019; Korhonen et al. 2020). AI can give probable answers to what–if questions; may be able to detect, for example, eventual frauds (Spraakman et al. 2015); and can suggest courses of action.

Mastering Predictive Analytics, MAs have the opportunity to own, analyze and drive a larger part of an organization's data, using procedures arraying from simple financial ratios to more forward-thinking techniques such as regression, clustering and factor analysis (Cokins 2014; Pickard and Cokins 2017). Thus, Prescriptive Analytics goes beyond the Predictive Analytics by endorsing one or more recommendation and solution and displaying the potential outcome (Appelbaum et al. 2017). More significantly, Prescriptive Analytics can use all forms of new data to re-prescribe and then refine prescriptions based on a feedback loop. In this context, by using Prescriptive Analytics, MAs will automatically offer the best decision choice scenarios and improve prediction accuracy by using deliverables such as reports, algorithms, models, codes and recommended actions (Cokins 2014; Spraakman et al. 2015; Appelbaum et al. 2017; Pickard and Cokins 2017).

BA undertaken by MAs where BD is existing may conduct to a Prescriptive Analytics tactic where a set of procedures and methods computationally identifies numerous alternative actions to be taken by management, given their complex goals and limits, to reduce business risk (Arnaboldi et al. 2017b). For instance, it could use social media to project the optimal marketing budget and diminish the risk of directing resources in the wrong market segment (Arnaboldi et al. 2017a; Arnaboldi et al. 2017b). Social media, as well as other novel and innovative exogenous data, could also be employed to re-run and re-estimate models based on variations in the socio-economic conditions, business environment, government policies and any other unforeseen events (Appelbaum et al. 2017; Oesterreich et al. 2019). Perceptibly, the Prescriptive Analytics approach is the most effective where the MA has more control over what is being modeled (Table 3).

Table 3. Opportunities and challenges regarding the MA's BA capabilities.

Data Skills	Opportunities	Challenges
Governance	• Integration of unstructured data (Warren et al. 2015; Appelbaum et al. 2017; Arnaboldi et al. 2017a, 2017b) • Enhanced value of data by mixing structured and unstructured data (Bhimani and Willcocks 2014; Richins et al. 2018) • Automatic generation/extraction of data (Möller et al. 2020) • Cost savings (Bhimani and Willcocks 2014)	• Large volume of data (Bhimani and Willcocks 2014; Wang and Song 2016) • Information overload (Quattrone 2016) • Data veracity (Bhimani and Willcocks 2014)

Table 3. *Cont.*

Data Skills	Opportunities	Challenges
Analytics	• Time savings and real-time data (Cokins 2013; Bhimani and Willcocks 2014; Krahel and Titera 2015; Vasarhelyi et al. 2015; Warren et al. 2015; Gärtner and Hiebl 2018; Korhonen et al. 2020)	• New techniques, technologies and software (Bhimani and Willcocks 2014) • Loss of data sovereignty, loss and theft of data (Wang and Song 2016)
Visualization	• Improve decision support, controlling operational and strategic planning (Warren et al. 2015; Nielsen 2018; Bergmann et al. 2020; Cavelius et al. 2020)	• Changing cost structure (Acito and Khatri 2014; Bhimani and Willcocks 2014) • Veracity, incorrect data and making incorrect decisions faster (Quattrone 2016)

Briefly, to conclude, the application of analytics to business problems is in its infancy in terms of development and dissemination. Opportunities for employing data assets to reduce costs, enhance revenue and manage risks abound and will continue to grow (Acito and Khatri 2014).

5. Discussion

While executives are open to moving towards BDA, this requires them to understand the change from their reliance on traditional data sources, and their appeal to a changed and developing knowledge base, founded on both economic transactions information and other data (Bhimani and Willcocks 2014; Krahel and Titera 2015). Besides, the new innovative data sources contribute to changes in decision-makers' behavior and their expectations of the involvement of MAs (Appelbaum et al. 2017; Andreassen 2020; Möller et al. 2020).

Five categories may synthesize Mas' activities: (1) defining and adapting the systems of internal control; (2) creating and handling data; (3) performing recurrent tasks, i.e., budgeting and reporting; (4) managing DA and carrying out ad-hoc studies; and (5) offering consultancy and advice to middle- and top- general management (Wang and Song 2016; Heinzelmann 2018). While the first three create the level of "technician", the last two are the ones that contribute to the level of "Business Partner". Towards this end, it is expected that the MA will be responsible for DA, ad-hoc studies (i.e., producing new analyzes, calculating new indicators and realizing new scorecards) and advice, working more closely with managers instead of being a mere information producer (Spraakman et al. 2015; Xu 2017; Coyne et al. 2018; Vitale et al. 2020). The "Business Partner" role requires MAs to have a forward-looking approach and to be more diligently involved in strategic planning, analysis and management support (Cavelius et al. 2020).

In addition, MAs may find themselves in the position of having to work in teams with data and computer scientists, and they will need their skills for proper communication with the other members of the team (Richins et al. 2018).

To comprehend and decipher huge amounts of data, companies are advertising new job profiles with different nominations (e.g., "industrial data scientist", "data scientist"), that need highly qualified manpower able to work with a large amount of information, possessing the ability to clean and organize large unstructured data-sets, owning expertise in visualization techniques, having analytical skills to detect correlations, make inferences and draw conclusions, as well as possess programming skills, comprising capabilities to employ statistical and general-purpose programming languages, while also possessing enhanced business understanding and having strong communication skills (Oesterreich et al. 2019).

Moreover, professional accountancy organizations such as IMA, CIMA and ACCA are promptly reacting to the business community's demands by adjusting their training offer to the labor market requirements and offering a revised competence framework, specifically, new training in the area of technologies and analytics skills. Additionally,

accountancy organizations are very active in studying and reporting BD and DA's impact on the profession (IMA 2013, 2019; CGMA 2014; ACCA 2016, 2020a, 2020b, 2020c, 2020d, 2020e; CIMA 2016; ICAEW 2019).

Furthermore, what is sure is that MAs must leave their comfort zone and champion BD and forward-looking DA in order to remain relevant in the business environment.

Another paradigmatic change of MA refers to innovative sources of data. In the past, most working time was assigned to chores related to finding the right data and collecting it manually, which was time-consuming, followed by analyzing tasks. In contrast, the last and smallest part of the job time was allocated for reporting and communicating results. Nowadays, there is an abundance of data that is being instantly collected by using appropriate tools, which leads to more time allocated to analyzing and reporting responsibilities. The outcome is that a substantial volume of internal data can now be accessed and accurately gathered in a faster and more efficient way.

In this context, it is acknowledgeable that the challenge now lies in extracting the value from these substantial data. The times of preparation of periodical accounts—for month/quarter/year-end—are now in the past, and real-time data visualizations and just-in-time analyzes will become available. Reporting will now have a considerably different significance in organizations, changing from a backward-looking to a future-oriented outlook, from hindsight to foresight.

It is important to note that the present evidence relies on the fact that MAs will be asked to present insights and foresight for the next horizon, representing the challenge for the future generation MAs. The new reports in the digitalized era will have to be dynamic and automatic and consider intelligent dashboards built on data visualization techniques that are audience-engaging. MAs will have to play a significant role in reporting change if they want to preserve their organizational influence. Moreover, control tasks are shifting as a consequence of distribution and sharing of data across organizations. The data will be digitally checked, and consequently embedded dynamic controls will have to be considered. Thus, also in the control area, MAs will transfer their attention to dynamic and maybe preventive controls and risk management, being able to utilize multiple data sources. This transformation will allow MAs to play a growing role in the governance, stewardship and leadership of their organizations (Bhimani and Willcocks 2014; Coyne et al. 2018).

Companies and professionals' digitalization is a disruptive reality that creates a favorable environment to explore new opportunities. Hereby, the MA function itself can harness BD and DA's power to transform itself and organizations (Spraakman et al. 2015; Richins et al. 2018; Schmidt et al. 2020) significantly. This metamorphosis will manifest itself in several directions across the accounting spectrum, from the accounting pyramid's transactional zone to the top-end of knowledge and value generation.

Against this background, MAs' function is changing in terms of specialization, workflow and tasks. Regarding specializations, there is a change from a pyramid shape to a diamond shape because of the synergic effect of emerging technologies and innovative data sources (Bhimani and Willcocks 2014). Traditionally, the MAs' function has included a structure heavily populated with personnel, most of them in execution roles, at the bottom of the pyramid. While gaining experience in time, they are promoted higher up the pyramid in middle or top management. The pyramid model is sturdy on retained knowledge. Still, it is also costly because it must compete for effective and sometimes expensive domestic workers to fill in skills gaps and scale-up resources.

Hence, in the digital era, the MAs' function tends to shift towards a diamond-shaped configuration. Many transactional activities that were executed by employees are now outsourced, being undertaken by external providers, usually in a lower-cost location. While there are fewer middle managers, there are increasingly more specialized experts on different issues. Shifting from pyramid to diamond structures may generate redistribution effects, hastened by digital technologies, in regard to where data, information and knowledge reside and how they are exploited.

It is by now generally accepted that the enhanced prominence of BA is driven by an explosion in the amount of new data available for analysis. Studies have shown that accounting executives seek to transcend their traditional responsibilities (of preserving an efficient, economic and effective operating model to provide financial reliability and guide strategic judgments about enterprise operations). Through BD and BA tools, accounting information is being arrayed in some organizations to alter business decisions (i.e., developing more profound and broader analysis levels much more quickly, and detecting key new trends from which recommendations can be mined). Such deployment is beginning to modify how the management accounting function succeeds in articulating the possibility for reformed utilization of resources and methods of trailing corporate strategies (Bhimani and Willcocks 2014; Nielsen 2018).

By using the BA, the MA assists business planning. Its aim is to ascertain new insights and connect business performance to business data since BA provides fact-based analytics approaches to learn a meaningful data pattern and then communicates insights using the recorded information's data visualization.

In conclusion, it would appear that, in regard to tasks and responsibilities, the challenge for MAs in the quick-changing era of BDA and Artificial Intelligence is complex: possessing a readiness to have an open, flexible and malleable mind-set. The other change vectors are developing the technical and analytical skills related to sciences like statistics and the use of analytic software platforms.

6. Further Research Developments

The impact of innovative sources of data, their characteristics that request new techniques to collect and use them, the new skills requested for this—all of these factors pose a multitude of questions for practitioners and academia, such as:

i How ready is the management accounting profession to confront and embrace this challenge, with regard to:
- MAs' proper acknowledgment of their focused and extended new role(s) (ACCA 2020a, 2020d);
- MAs' tasks and responsibilities regarding DA technology application (Brands and Holtzblatt 2015; CIMA 2016; ICAEW 2019; Moll and Yigitbasioglu 2019);
- MAs' willingness to enter this new area of competence (Rikhardsson and Yigitbasioglu 2018; IMA 2019);
- MAs' power/ability of ensuring—through the use of DA—that data-to-insight is effectively tuned into decision-to-value (IMA 2019)?

ii What is the power of innovative data sources, specifically, which are the (im)perceptible limits and elusive boundaries of DA, with regard to:
- Enabling better control;
- Inducing some management accounting practices to become obsolete because of real-time data from customers and through the IoT;
- Supporting inference, prediction and assurance in management accounting tasks;
- Impacting less-used management accounting techniques, i.e., zero-based budgeting or scenario and contingency planning (Moll and Yigitbasioglu 2019; ACCA 2020c)?

iii What are the opportunities BA are bringing in the way MAs handle BD, with regard to:
- Assessing the added-value of BD for decision-making purposes;
- Identifying the control systems that BD permits, in the context of unstructured innovative data;
- Bringing added value to strategic decisions by using Visual Analytics to structure BD?

7. Conclusions

Digitalization has a significant impact on the way organizations function, predominantly impacting the output and analysis of BD, as part of management decision-making support. Thus, data explosion and the use of emergent technologies are distressing organizations nowadays and creating dilemmas for management.

BD lays the foundation to implement a radical change in the organization of the management accounting function. This comes from its potential to impact the decision-making process in organizations in the long term. The process of decision-making seldom focuses on how to identify causes of events inferring relationships or predict future events. The decision-making process based on data analysis focuses on patterns and connections in data that can be used to define actions. When a pattern is identified and considered stable over time, decision-makers can act based on it. These changes in the process of decision-making represent a disruptive force that might significantly shift the role of MAs in organizations, the usage of accounting data and the organization of the accounting function. This primarily means that MAs will increasingly have to share accountability and responsibility for classical management accounting analysis (i.e., analyses of profitability for customer and product mix decisions, capital budgeting valuations, decisions on outsourcing, stock optimization, and incentive system design with other functions). Secondly, other functions' decision-making process will be also impacted as accounting data will become widely accessible through Business Intelligence and DA technologies solutions (i.e., decisions on marketing campaigns, employee developments and production maintenance).

The paper's main conclusion is MAs have the opportunity to play a vital role in the employment and diligence of BA in their organizations as they step outside the boundaries of traditional, transaction-based accounting into the zone of analytics. This emerging trend will alter how MAs analyze and infer data extracted from external and internal innovative sources. Enhancements in the capacity of capturing, processing, storing, analyzing, visualizing and sharing data will have particular relevance on how MA perceive their novel role(s), especially on how they undertake their work, with their daily chores, tasks and responsibilities. This may be considered a promising aspect since new data capabilities qualify the accountancy profession to radically advance decision-making crosswise organizations.

From a theoretical viewpoint, this paper contributes to the development of knowledge by recalling the Abbott theory (1988), which might appear to explain current developments among the information professions usefully (Abbott 1988), especially in the field of management accounting. This is a subject worthy of further in-depth study. First, seminal contributions have been made by exposing not only a diagnosis but also a corollary of features regarding practices in management accounting in the context of innovative sources of data. Subsequently, it comprises a compendium of new tasks and responsibilities of MAs as an adaptive response to the advancement and inherent challenges of BD. Consequently, it identifies which are the novel required BD and DA additional digital skills and capabilities of MAs' job profile.

Besides, our findings provide additional information about many examples across the profession regarding innovative data sources used to facilitate new insights about innovative business processes; they focus on areas of the most significant risk: forecasting and prediction. This allows MAs to improve financial resource management and bolster the decision support they offer to other business functions. The remaining issues are subject to further research since, conversely, in practice, many MAs are in the early stages of using BD and more advanced analytics, and significant opportunities are still to be realized.

Our research may be considered a further validation of the fact that Prescriptive Analytics represents the future of BD. However, it is still a long way away from becoming a common language. The prospects are immense, but an immense amount of data is required to make accurate and precise decisions. Our analysis leads to the conclusion that only a minority of organizations and industries have the aggregate of data and data sets necessary

in order to use Prescriptive Analytics. Nevertheless, it is expected that in 5–10 years this will be as ordinary as Business Intelligence is nowadays.

The broad implication of the present research is that, on the one hand, an itinerary was shaped to help practitioners in management accounting acknowledge and evaluate potential opportunities, challenges and risks. On the other hand, for professional accounting associations and bodies, a lens was provided to prioritize the holding and seizing of jurisdiction as a vital effort toward attaining security and development. Simultaneously, for academia, the framework could be used to step beyond Abbott's own work (Abbott 1988), to facilitate, for instance, an investigation of the roots and magnitudes of gender and race stratification amid the emerging information profession of management accounting. Since the expounding power of Abbott's theory has been historical (Abbott 1988), its innovative, avant-garde value remains an open question (Furness 2019). Ideally, our findings ought to be replicated in a study where this question will find an answer, especially in the current context of technological revolution and inherent socio-economic change for all professions.

Author Contributions: Both authors contributed equally at all paper's parts. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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Note: The final sample of 45 scientific publications (ACCA 2020a; Acito and Khatri 2014; Andreassen 2020; Appelbaum et al. 2017; Arnaboldi et al. 2017a; Arnaboldi et al. 2017b; Bergmann et al. 2020; Bertsimas and Kallus 2020; Bhimani and Willcocks 2014; Brands and Holtzblatt 2015; Bredmar 2017; Castellano et al. 2017; Cavelius et al. 2020; Cockcroft and Russell 2018; Coyne et al. 2018; Dilla et al. 2010; Dinan 2015; Gärtner and Hiebl 2018; Griffin and Wright 2015; Heinzelmann 2018; Knudsen 2020; Korhonen et al. 2020; Krahel and Titera 2015; Liu 2016; Luen et al. 2015; Meng 2018; Moll and Yigitbasioglu 2019; Möller et al. 2020; Nielsen 2018; Oesterreich et al. 2019; Pickard and Cokins 2017; Quattrone 2016; Richins et al. 2018; Rikhardsson and Yigitbasioglu 2018; Runkler 2012; Schläfke et al. 2013; Schmidt et al. 2020; Schneider et al. 2015; Spraakman et al. 2015; Vasarhelyi et al. 2015; Vitale et al. 2020; Wang and Song 2016; Warren et al. 2015; Wongsim et al. 2019; Xu 2017; Zhou and Xia 2018) includes 36 articles, 7 conference proceedings and 2 book chapters, with relevant insights for our research objective. In addition to academic studies, we considered relevant for our aim 16 professional publications (ACCA 2016, 2020b, 2020c, 2020d, 2020e; CGMA 2014; CIMA 2016; Cokins 2013; Cokins 2014; Drew 2018; ICAEW 2019; IMA 2013; IMA 2019; Lin 2016) issued by IMA (Institute of Management Accountants), ACCA (Association of Chartered Certified Accountants), CIMA (Chartered Institute of Management Accountants) and CGMA (Chartered Global Management Accountant), or published in professional journals *CPA Journal*, *Accountancy Journal* or *Strategic Finance*.

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