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The Evolution of Management Accountants' Digital Skills in Industry 4.0: A Qualitative Approach

Abstract. *The Fourth Industrial Revolution generated changes not only in the accounting and financial activities and processes but also in the set of digital competencies that management accountants must demonstrate. This paper aims to examine the impact of digitalisation in managerial accounting in terms of the changes generated in the set of digital skills. By wielding an inductive cross-sectional qualitative approach, we examined longitudinally and comparatively the evolution of the curricula in the last decade, defined by two widely recognised qualifications provided by the most important international professional bodies in managerial accounting – the Chartered Institute of Management Accountants (CIMA) and the Institute of Management Accountants (IMA). The research's findings highlight that currently, the digital competencies management accountants should demonstrate are focused on both technologies already widely adopted by the business environment, such as cloud computing, big data, and data analytics, but also on emerging technologies, such as artificial intelligence, machine learning, blockchain, and Internet of Things. Even though at the beginning of the analysed period, the set of digital competencies was relatively narrow, once most industries started navigating Industry 4.0, it extended, thus allowing management accountants to continue providing valuable information and embrace the new role of advisors. These results emphasise the changing role of the management accountant through the lens of digitalisation, providing valuable insights for practitioners and universities regarding the importance of an adequate set of competencies vital in a highly digitalised profession.*

Keywords*: management accounting, digitalisation, digital skills, Industry 4.0, accounting education.*

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Еволюція цифрових навичок професійних бухгалтерів в умовах четвертої промислової революції: якісний підхід

Анотація. *Четверта промислова революція спричинила зміни не лише в сфері управління, зокрема в бухгалтерських та фінансових процесах, але й у наборі цифрових компетенцій, якими повинні володіти бухгалтери з управлінського обліку. Мета цього дослідження – оцінити вплив цифровізації на сферу управлінського обліку з точки зору змін в наборі цифрових навичок професійного бухгалтера. Використовуючи індуктивний перехресний якісний підхід, автори всебічно дослідили еволюцію навчальних програм бухгалтерів за останнє десятиліття, визначену двома широко визнаними кваліфікаціями, наданими найвідомішими міжнародними професійними організаціями в галузі управлінського обліку – Дипломованим інститутом управлінських бухгалтерів (CIMA) та Інститутом управлінських бухгалтерів (IMA). Результати дослідження свідчать, що наразі цифрові компетенції, які мають продемонструвати бухгалтери з управління, зосереджені як на технологіях, які вже широко прийняті в бізнес-середовищі (наприклад, хмарні обчислення, великі дані та аналітика даних), так і на нових технологіях, таких як штучний інтелект, машинне навчання, блокчейн та Інтернет речей. На початку аналізованого періоду, коли більшість галузей почали переходити на Промисловість 4.0, набір цифрових компетенцій був відносно вузьким. Однак, згодом він розширився, що дозволило бухгалтерам з управлінського обліку ефективно продовжувати професійну діяльність та приймати нову роль консультантів. Таким чином, завдяки цифровізації відбулася зміна ролі бухгалтерів з управлінського обліку. Це дослідження надає цінну інформацію для практиків та університетів щодо адекватного набору компетенцій, життєво важливих у професії бухгалтера, яка сьогодні суттєво цифровізована.*

Ключові слова: *управлінський облік, цифровізація, цифрові навички, четверта промислова революція, бухгалтерська освіта.*

INTRODUCTION

The Fourth Industrial Revolution, also called Industry 4.0, caused significant changes by modifying operational processes and activities from almost all (if not all) industries. This context determined the evolution of the management accountants' skills required to assist companies in navigating the current highly digitalised business environment. The role of international professional bodies (IPBs) in maintaining the relevance of the profession has been highlighted over time (King & Davidson, 2009), especially in the current context (Tsiligiris & Bowyer, 2021), as the IPBs continued updating the syllabi as a result of the increased level of digitalisation within the profession. Given the continuous collaboration between IPBs and the business environment, the requirements for becoming a certified management accountant provide clear directions on the future skills all practitioners, certified or not, must demonstrate.

The continuous learning by the IPBs (CGMA, 2013; CIMA, 2015; Deloitte and IMA, 2018), and ACCA (2012), emphasise that accountants must work effectively with the new technologies; otherwise, both individual practitioners and the profession might disappear. In response to the digitalisation practices, the International Federation of Accountants (IFAC) published in 2012 a preliminary version with proposed changes for the International Education Standard (IES) 2 by extending the Information Technology (IT) section, the new standard being applicable from 2015 (IFAC, 2014). To respond to these changes, the IPBs modified the curriculum by integrating over time more IT-related skills, focusing mainly on management and accounting information systems, along with emerging technologies at that time, such as Big Data, cloud computing, and data mining, also including information security aspects. The latest version of IES 2 (IFAC, 2019), applicable from 2021, continues the expansion of the IT section, covering all accounting processes, from data analysis to reporting performed by wielding IT solutions.

Although the academic environment started updating the syllabi so that future accounting professionals would demonstrate sufficient digital skills (Stanciu & Rîndaşu, 2017), the changes are delayed and, in some cases, do not sufficiently develop the necessary knowledge, as some of the technologies might be taught strictly at a conceptual level (Rebele & Pierre, 2015; Guşe & Mangiuc, 2022). The wide adoption of emerging technologies in a relatively short time accentuated the gap between companies' needs regarding the practitioners' skills and the competencies developed during academic training (Whysall et al., 2019). Existing research recognises the

critical role that higher education institutions (HEIs) have in preparing future practitioners but also admits that universities sometimes fail to define a comprehensive curriculum to develop the graduates' set of skills (Pasewark, 2021). Besides the active collaboration between HEIs and the business environment, another element that can assist universities in implementing the necessary changes in the curriculum might be the alignment to the requirements defined by IPBs (Apostolou et al., 2022), as IPBs seem to have a broader understanding of the business environment's needs, thus better managing to define an adequate set of digital skills.

Analysing the evolution of the profession through digitalisation, recent studies focused mainly on the evolution of the role from the practitioners' and organisations' perspectives (Coman et al., 2022; Gulin et al., 2019) and have analysed the impact within specific activities (Varaniūtė et al., 2022), researchers emphasising the need to continue exploring how digitalisation determines the evolution of the management accounting practitioners' role (Bhimani, 2020). Tsiligiris and Bowyer (2021) conducted a review of technical publications developed by representative IPBs in the accounting field to study the impact determined by Industry 4.0 in the set of skills; however, IPBs do not always include all these competencies in their curricula due to limitations such as the low-adoption level of some technologies. Moreover, this approach does not capture the evolutionary perspective. Thus, the current research aims to analyse the impact generated by Industry 4.0 on the requirements defined by representative IPBs in the managerial accounting field by examining the evolution of the set of digital skills. To achieve this objective, we performed a content analysis of the curricula defined by two IPBs with a global presence, examining the data collected longitudinally and comparatively using both manual and automated techniques.

The present paper is divided into four sections as follows: the first section analyses the relevant literature regarding the need for revamping the set of digital skills indispensable for management accounting practitioners and the IPBs' role in accounting education; in the second section, we detail the research methodology, followed by the presentation of the obtained results from the content analysis, and finally we present the conclusions, limitations, and future research directions.

LITERATURE REVIEW

Industry 4.0 and globalisation determined the evolution of the skills so that practitioners can perform effectively in diverse settings characterised by cultural differences and dynamic business environments (Chaplin, 2017; Winterton & Turner, 2019). The digital transformation of the accounting profession is driven by (1) the HEIs curriculum's changes, which focus on developing the practitioners' essential skills and (2) professional bodies which concentrate on technical skills, as both HEIs and IPBs are trying to respond to the business environment's changing demands and improve future practitioners' employability (Bonzanini et al., 2020). In this context, digitalisation led to new roles for accountants and opportunities for the profession's evolution (Ionescu-Feleagă et al., 2022).

Greenwood et al. (2002) consider that one of the IPBs' prominent roles is to represent the profession outside it. By assuming the responsibilities of providing initial training, certification, continuous education, and maintaining the quality of services performed by members, IPBs are considered gatekeepers of the profession (Carter & Mahallati, 2019). Although IPBs and universities have historically coexisted as two separate pillars of accounting education and training (King & Davidson, 2009), IPBs are currently more prepared to cover the organisations' needs determined by the digital transformation and automation of the profession (Tsiligiris & Bowyer, 2021).

Although there are undeniable benefits resulting from the collaboration between universities and IPBs, the trend observed in emerging countries is for HEIs to pass the responsibilities of defining the curricula to the professional bodies that exercise direct control over accounting education, thus, leading to a reduced involvement of the universities due to the inconsistencies between IPBs and HEIs' visions (Bonzanini et al., 2020; Verhoef & Samkin, 2017). In contrast, an independent coexistence continued in developed countries, despite the solid strategic partnerships regarding programs' accreditation and exemptions (King & Davidson, 2009). However, aligning the curriculum to the directions defined by the IPBs seems to support the increase of future practitioners' employability. By analysing the competencies defined by professional bodies in Canada and the business environment's expectations, Uwizeyemungu et al. (2020) note that the current set of skills manages to respond to the organisations' expectations. However, although IPBs contribute significantly to the development of accounting education, the relevant literature underlines their hegemonic role, highlighting the IPBs' inhibitor role in developing HEIs' curricula (Kotb et al., 2019).

The skill gap is defined as "the difference between the level of skills which the industry desires from the students and the skill level actually possessed by them" (Sangwan & Garg, 2017, p.110), being determined by the perceived differences between the labour market and HEIs. Tan & Laswad (2018) argue that the significance and nature of the gaps are determined by the degree of inclusion in the education plans of the skills required by the business environment, along with the teaching and assessment, considering that a gradual development of the skills set does not represent an optimal solution in reducing the gaps. Nevertheless, given the steep evolution determined by Industry 4.0 and globalisation, the continuous identification of skills required by the labour market and their inclusion in the curriculum, taking into account the complexity and variability of HEIs' environment, seems to be impossible to achieve (Pham & Jackson, 2020). In this context, Cheng et al. (2022) consider that the transfer of responsibilities from state institutions to universities is not an optimal approach, arguing that the skills gap can be reduced only through a

transparent and effective collaboration between HEIs, companies, and state institutions. Considering the fact that HEIs operate in countries with competitive and dynamic business environments, Moore and Morton (2015) propose that future practitioners should focus more on learning how to learn rather than concentrating on specific job-related skills. Moreover, Căpușneanu et al. (2020) emphasise that a sufficient set of skills can be improved only through continuous collaboration between the business environment, IPBs, HEIs, and scholars.

The academic environment constantly updates the curriculum (Bridgstock & Jackson, 2019; Cunha et al., 2022; Guşe & Mangiuc, 2022), but often the approach can be perceived as superficial, failing to integrate all the necessary competencies defined by IPBs and the relevant literature. Therefore, the responses are sometimes late, leaving room for improvement. This relatively slow evolution of HEIs' curricula is determined not only by the educators who sometimes focus predominantly on transmitting the knowledge and assessing learners' skills, concentrating less on the practical implications, but also as a response from students which favours superficial learning processes (Al-Htaybat et al., 2018). In assisting future practitioners, some universities included business simulations in the curriculum as educational alternatives to improve learning outcomes, thus increasing the degree of motivation determined by using new educational tools so that students can better understand the accounting function's role as a fundamental part of management and decision-making processes (Calabor et al., 2019; ElKelish & Ahmed, 2022).

If HEIs and IPBs fail to address the knowledge gap, the business environment might start recruiting practitioners from other fields that master the required set of skills. By attempting to assist learners in gaining as many competencies as possible from different domains, the study programs seem to fail prioritizing critical competencies, thus affecting the profession's legitimacy (Douglas & Gammie, 2019). Therefore, the reduction of entry-level opportunities in the accounting field determined by digitalisation and automation of processes highlights the need for reframing accounting education (Herbert et al., 2021).

RESEARCH METHODOLOGY

The study sought answers to the following research questions:

RQ1. What were the main changes in the IPBs' curriculum for certification in the management accounting field regarding digital skills?

RQ2. What does the comparative analysis reveal about IPBs' curriculum for certification in the management accounting field regarding digital skills?

Research design

To achieve the research's objective, we analysed the curricula defined by two IPBs: the Chartered Institute of Management Accountants (CIMA) and the Institute of Management Accountants (IMA), both having a global presence and including more than 700,000 members at the end of 2022. The examined IPBs offer several qualifications and for this study we chose to examine the curricula for Chartered Global Management Accountant (CGMA) – provided by CIMA and the Certified Management Accountant (CMA) – provided by IMA, as these represent the most comprehensive qualifications in the management accounting field. Starting with a systematic analysis of the curricula and competency frameworks defined by the two IPBs, aiming to identify and explore the evolution of the digital skills, the present research adopts an interpretive inductive approach based on qualitative transversal archival research. The qualitative examination of the curricula can reduce ambiguity and develop clear study maps (Yap et al., 2014), content analysis being one of the most widely used research techniques in the social sciences field (Hopkins & King, 2010). Moreover, considering the proposed comparative analysis, this study allows the identification of similarities and differences (Holder et al., 2013). This technique allows exploring both manifest content – visible components and latent content – the meaning that can be determined by manifest content (Saunders et al., 2019), facilitating a comprehensive analysis of the practitioners' necessary digital skills while also capturing other aspects that cannot be quantified. The research design is presented in Figure 1, highlighting the wielded research framework.

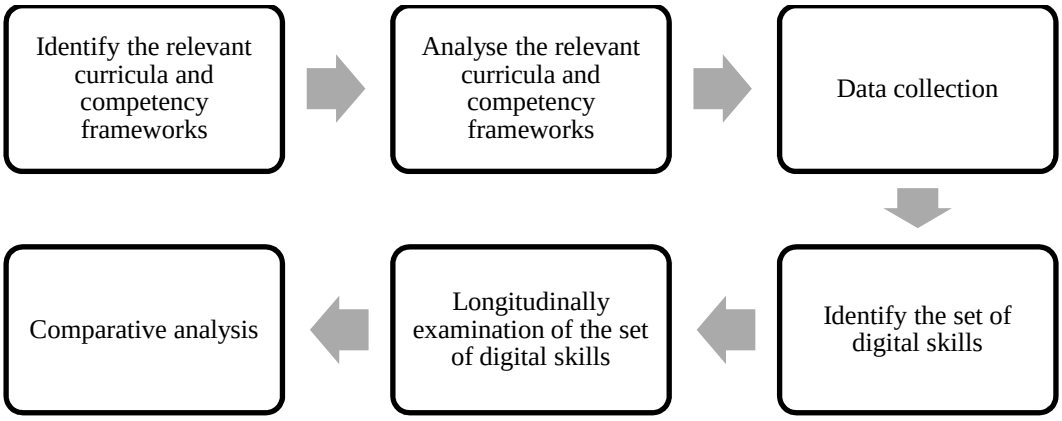

Figure 1. **Research design**

Source: Authors' processing.

Data collection

The data were collected by analysing in a sequential linear approach the curricula and competency frameworks defined for 2010-2022. The two IPBs organise the syllabi into exams/sections, each having a generic name regarding the set of skills, with separate exams/sections defined for general digital skills. At the same time, specific competencies can also be included in other parts of the syllabi. We examined all the curricula and competency frameworks defined during the specified period. The selection of the period was determined by the main changes in the IES2 from 2014, respectively 2019, as both IPSs are members of IFAC. Table 1 presents the list of exams and sections of the curricula that refer to digital skills required for management accounting practitioners to obtain the analysed qualifications.

Table 1. **List of exams/sections defining digital skills**

CIMA	IMA
Advanced Management Accounting (P2)	Internal Controls
Management Accounting (P1)	Cost Management
Managing Finance in a Digital World (E1) [1]	Technology and Analytics[2]
Managing Performance (E2) [3]	
Risk Management (P3)	
Strategic Management (E3)	

Note: [1]Before 2019 – Organisational Management;
[2]Added from 2019;
[3]Before 2019 – Project and Relationship Management

Source: Authors' processing based on the data collected.

Data analysis

The digital skills were identified through a content analysis of each curriculum and competency framework. In the first stage, we used manual methods, and in the second stage, we deployed a computerised analysis using the text mining function of VosViewer. This approach allows a much more detailed examination, thus reducing the risks of missing important information, as the manual analysis is still considered superior (Sjøvaag et al., 2012; Syyrilä et al., 2021). At the same time, by employing automated text mining, in addition to the benefits related to time reduction and improved ability to process a large volume of information (Lee et al., 2020; Brunzel, 2021), we were able to observe connections that were not as visible when performing the manual examination (van Eck & Waltman, 2022).

RESULTS AND DISCUSSION

The most recent versions of the IES 2 (2014, 2019) used the generic term Information and Communication Technologies (ICT), not specifying distinct IT solutions that practitioners should master, the set of skills being presented in a general manner, thus allowing IPBs to include the technologies deemed appropriate.

After an initial analysis of the curricula and competency frameworks, it can be noticed that both IPBs include, since the beginning of the analysed period, skills related to information systems, data mining, and data warehouse. However, in addition to the information systems, no other explicit requirements about other technologies are included, even though the literature highlighted the benefits of using cloud platforms (Du & Cong, 2010; Defelice & Leon, 2010) and Big Data (Chen et al., 2012). This approach adopted by the analysed IPBs can be explained by the fact that many of the technologies and IT solutions widely used nowadays were still emerging at that time, being used by only a few large companies that chose the pioneering role in the digitalisation of management accounting processes. On the one hand, CIMA initially included in the curriculum general requirements regarding the digital skills that future certified professionals must master, focused on transforming organisations through technology and increasing the dependence of companies on information systems. On the other hand, IMA focuses mainly on the importance of controls meant to improve data accuracy and security.

The first significant changes focusing on digital skills were introduced in the CGMA curriculum in 2015, when both the relevant literature and various companies, which undertook the pioneering role in digitalising the accounting profession (i.e. the Big4 companies), began presenting clear benefits of technologies such as Big Data (Bhimani & Willcocks, 2014; Deloitte, 2012; Moffitt & Vasarhelyi, 2013; PriceWaterhouseCoopers, 2014) and cloud computing (Dimitriu & Matei, 2014; KPMG International, 2012; Tarmidi et al., 2014). The second wave of significant changes within the CGMA certification took place in 2019 by reconfiguring the curriculum to highlight the importance of digital strategies as most industries begin navigating Industry 4.0 – dominated by artificial intelligence, blockchain technologies and the Internet of Things (IoT).

IMA, unlike CIMA, does not make significant changes to the set of digital skills required for the CMA certification until 2020, although in 2017 presented the technology component in the competency framework as being one of the essential pillars of the accounting profession, emphasising that the efficient and effective use of information systems and IT solutions increase the operational performance (IMA, 2017).

As noticed from the longitudinal comparative analysis of IT solutions identified within the curricula, presented in table 2, CIMA assumed, in the last decade, the pioneering role in the digitalisation of the profession by including in a timelier manner a variety of emerging technologies. Moreover, CIMA also incorporated technologies that are not usually wielded in the management accounting processes, such as 3-D printing, but which have a significant potential to modify specific fields of activity, considering important that practitioners can understand and objectively evaluate the impact of solutions on economic activities.

Table 2. **Technologies and IT solutions identified in the curricula**

Technologies and IT solutions	CIMA	IMA
3-D printing	2019	-
Artificial Intelligence	2019	2020
Big Data	2015	2020
Blockchain	2019	2020
Business Intelligence	2019	2020
Cloud Computing	2015	2020
Computer-Assisted Audit Techniques	2010	-
Customer Relationship Management Systems	2010	-
Data mining	2010	2020
Data warehouse	2010	2020
Database Management Systems	2010	2020
E-commerce	2010	-
Enterprise Resource Planning Systems	2010	2015
Extract, Transform, Load Systems	2019	-
IoT	2019	-
Knowledge Management Systems	2010	-
Manufacturing Resource Planning Systems	2010	-
Material Resource Planning Systems	2010	2010
Mobile technologies	2019	-
Robotic Process Automation	2019	2020

Source: Authors' processing based on the collected data.

Considering that the analysed digital skills from 2010-2022 were identified based on the information available in the curricula, it is possible that some of the competencies from the 2010 curricula were introduced before 2010. However, as the IPBs do not publish a detailed track of the changes, it was impossible to precisely identify the year of introduction.

In addition to the digital skills set, since 2010, both IPBs emphasise the need for practitioners to understand information security aspects such as data encryption, the importance of backups, access control and cyber-attacks. During the examined period, there were no significant changes regarding data security skills, most of the key concepts being already included in the first analysed syllabi, with just a few exceptions generated by the evolution of the techniques used within cyber-attacks.

In 2019 CIMA included, in the E1 exam, a section dedicated to the ethical use of IT solutions, emphasising the importance of sustainable approaches in the digitalisation of processes. The relevant literature highlighted that some of the currently emerging technologies, if not used appropriately and without respecting the ethical principles, can create disruptions in the economic processes, such as problems related to data security, confidentiality, transparency (Jones et al., 2014; Lehner et al., 2022), and also more complex issues, such as algorithmic collusion determined by the improper use of artificial intelligence solutions (Calvano et al., 2021; Hansen et al., 2021). However, several previous studies have highlighted that artificial intelligence can also be wielded to reduce these ethical challenges (Rodgers et al., 2023; Vărzaru, 2022).

In 2019 CIMA structured the curriculum to accentuate the profession's role in a highly digitalised environment, where practitioners become advisors by assisting companies in effectively navigating the digital transformation. The same approach has been used since 2020 by IMA when it revamped the curriculum by focusing more on the digitalisation component. Figure 1 shows the certified practitioners' profile in the context of the digitalisation of the management accounting field, based on the representative assertions regarding digital skills from the 2022 CGMA curriculum (CIMA, 2021a; 2021b; 2021c).

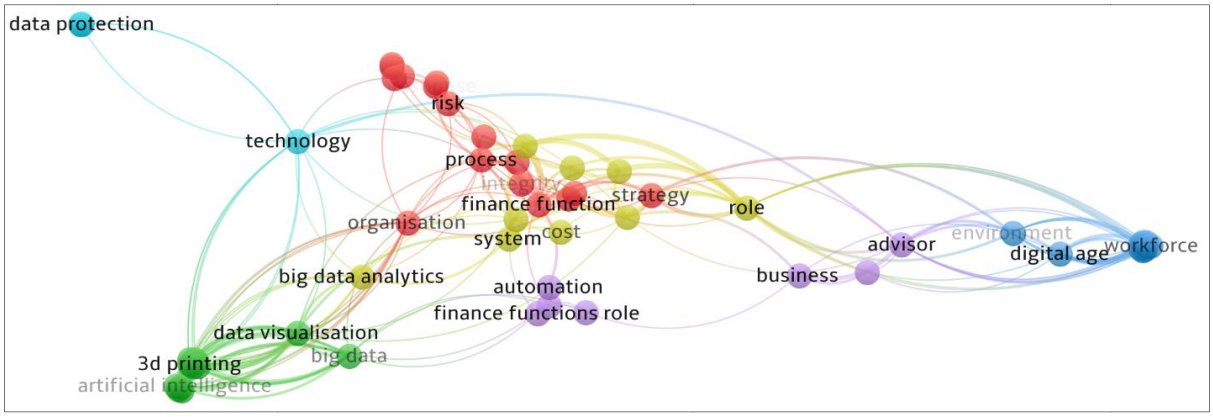

Figure 2. **Certified practitioners' profile in the context of digitalisation – network view**
Source: Authors' processing using VosViewer based on the collected data.

As observed in Figure 2, the accounting practitioners' profile in the context of digitalisation, focuses on six main pillars of competencies, as per the representative statements from the CGMA's curricula:

– The red cluster (16 elements): digital transformation of the company, starting from the financial function and taking into account the aspects related to risks and the response to risk;

– The green cluster (12 elements): key technologies that have the potential to change managerial accounting processes, but also aspects related to data visualisation techniques;

– The blue cluster (10 elements): the importance of digital skills in Industry 4.0, focusing on the significance of the human resource development;

– The yellow cluster (9 elements): transforming data into a digitalised environment allowing accountants to adequately support the decision-making process;

– The purple cluster (7 elements): the practitioners' new role as advisors able to propose the necessary strategies in a disruptive environment determined by digitalisation;

– The turquoise cluster (4 elements): data protection and digital responsibility to ensure the fundamental data characteristics by leveraging IT technologies.

In terms of the density of the elements, the main keywords that define the accountants' digital profile can be observed in Figure 3.

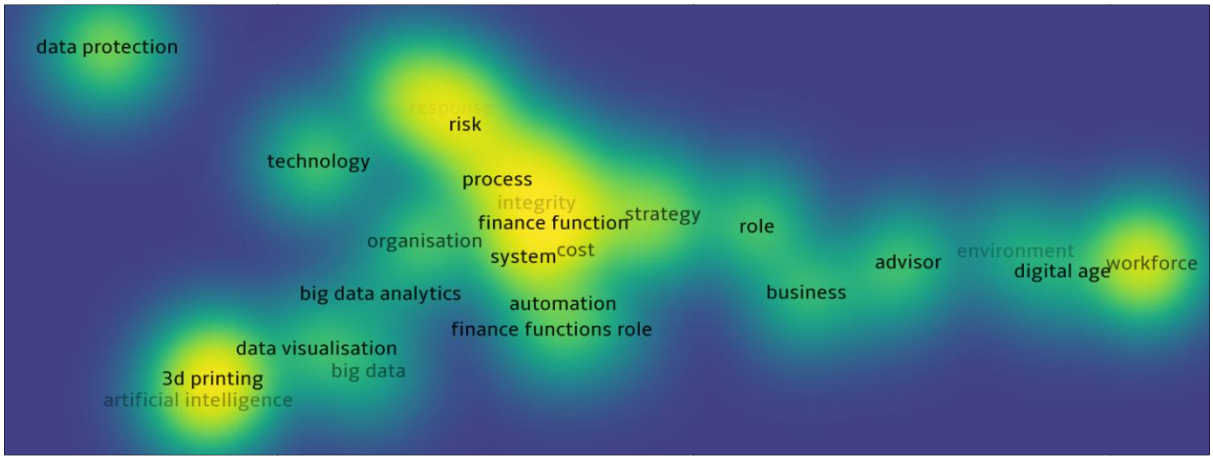

Figure 3. **Certified practitioners' profile in the context of digitalisation – density view**
Source: Authors' processing using VosViewer based on the collected data.

Unlike CIMA, IMA does not present a consistent set of representative assertions, thus not allowing to conduct a similar analysis. Therefore, we resorted to another content analysis based on the most recent version of the curriculum defining the CMA-certified practitioners' profile. Thus, it can be seen that the primary indispensable skills to support companies in navigating Industry 4.0 (IMA, 2020) focus on:

– Appropriate use of visualisation techniques to communicate complex information;

– Effective use of statistical tools for performing financial and economic forecasts;

– Effectively handling large data sets through specific data mining and analysis techniques;

– Identifying and explaining the challenges generated by wielding different systems for managing both financial and non-financial information;

– Identifying suitable channels for appropriately delivering results through the effective use of visualisation techniques;

– Identifying IT solutions that can improve data processing efficiently and effectively;

– Identifying, evaluating, and proposing effective IT solutions to ensure data security;

– Recognising the potential of emerging technologies to improve operational activities and data quality;

– Understanding the benefits and associated challenges determined by digitalising the processes;

– Understanding cyber-attacks related risks, evaluating controls and proposing solutions to mitigate cyber-risks;

– Understanding the transformation of data to actionable insights;

– Understanding visualisation techniques' benefits and limitations;

– Wielding IT solutions for integrating financial and non-financial information.

After comparing the curricula for both qualifications, it can be noticed that there are relatively insignificant differences regarding the practitioners' role in the digital context, the main difference being the emphasised paradigm shift in the accountant's role, migrating toward a management advisor position, as foreseen by the literature long before the emergence of Industry 4.0 (Siegel, 2000). While the syllabi defined by CIMA mainly emphasis the practitioners' new role, focused on the proposal of digital strategies, IMA limits the set of digital skills to particular solutions without offering representative assertions. Moreover, CIMA also highlights the need for practitioners to have a clear understanding of the digitalisation's impact in terms of legal and social implications.

CONCLUSIONS

The research's objective was to study the impact generated by digitalisation of the managerial accounting activities on the requirements defined by IPBs, examining the evolution of the certified practitioners' digital skills.

The first significant finding was determined by the longitudinal content analysis, which highlighted an increase in digital skills required by IPBs. At the beginning of the examined period, the curricula did not refer to specific technologies, although many of them were already examined by scholars (Du & Cong, 2010; Horngren et al., 2002; Baldwin et al., 2006). Technologies such as Artificial Intelligence, RPA, and blockchain were included in the curriculum when the adoption degree increased, an aspect that emphasises the close collaboration between IPBs and the business environment. Also, in the case of the curricula defined by CIMA, we identified required skills regarding technologies that are not used in the managerial accounting activities, but can affect the operational processes of the business environment, thus acknowledging changes in the accounting practitioners' role, focusing on management advisory activities.

The second significant finding was emphasised by the comparative examination of the syllabi defined by the analysed IPBs. In the context of the increasing degree of digitalisation within the profession, both CIMA and IMA highlighted that practitioners must have sufficient knowledge about technologies that directly impact the profession to propose digital strategies for maintaining and increasing competitive advantages. Although within the syllabi defined by IMA, a significant series of technologies was included relatively late, compared with the evolution of the curricula defined by CIMA, it seems that now the set of digital skills is similar, even if some competencies were included after a significant time, as in the case of data warehouses and database management systems skills. The differences focus on various management systems and technologies, such as IoT, mobile technologies, and 3-D printing. At the same time, the curricula include competencies regarding information security and techniques practitioners can use to identify, mitigate, and prevent security incidents. From the beginning of the analysed period, both IPBs highlighted the importance of data security and updated the curriculum to properly reflect the evolution of the required skills over time. Although no significant differences were identified in terms of the digital technologies included in the curricula, the comparative longitudinal analysis reflects that CIMA has assumed the pioneering role in the professions' development by including in the curriculum a set of technologies which, although was not widely adopted, allowed practitioners to have a greater understanding of these solutions, thus being able to propose processes' digitalisation so that organisations could leverage competitive advantages.

The study's results emphasise that the impact generated by the Fourth Industrial Revolution was significant, determining the inclusion of skills regarding both technologies that currently have a high degree of adoption and emerging technologies. Although new technologies will continue to appear and given that the economic directions focused on the sustainable development of companies, the digital skill set may undergo further changes, this research contributes to improving the understanding of the impact of Industry 4.0 in the context of the evolution of the management accounting practitioners' digital skills.

Limitations

While the current research was limited exclusively to the curricula defined by the two most important management accounting IPBs, most universities offering bachelor and master programs in accounting are accredited by CIMA or IMA. Given the broad set of digital skills defined by IPBs, a future research direction could focus on analysing the extent to which the evolution of management accounting practitioners' profiles is aligned to labour market requirements. The comparative analysis of changes regarding the set of skills might also be continued by including other representative management accounting IPBs.

The research's findings have implications for the HEIs and business environment. Most universities continue updating their curricula to meet the business environment's demands, but the changes often take time, affecting future graduates' career paths. Thus, universities can attract many more future practitioners by becoming pioneers in the digital transformation of the profession.

By aligning the competency grids with the directions defined by IPBs and relevant scholars in accounting education, HEIs can significantly reduce the gap between the current state of digital evolution, the business environment's expectations, and professional training. However, HEIs must retain an optimal level of autonomy in defining the curriculum to maintain the segregation between the roles in accounting education. From a managerial point of view, given the extensive set of digital skills, companies should provide practitioners with an appropriate framework for wielding their competencies, thus assisting organisations in navigating Industry 4.0.

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