A profession in transition: actors, tasks and roles in AI-based accounting

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Abstract

Purpose – This article ties in with current debates on the digital transformation of society and the consequent work changes. Using an artificial intelligence (AI)-based accounting context, the focus of this paper is on actors, roles and tasks and related skills on an individual level. The authors look at the effect of AI-based "smart" technology on the workforce in the broader accounting profession taking an intrafirm perspective, yet acknowledging that the digital transformation encompasses a much larger field in the financial sector.

Design/methodology/approach – The authors conduct a Delphi study to identify the new roles and tasks in future accounting. In addition, the authors use expert workshops to clarify the related tasks and skills and determine whether either humans or AI-based technologies perform the roles or collaborate in professional accounting occupations.

Findings – The results show that tasks and skills for existing professional occupations in the broader acounting context will be subject to major changes in the next 10 years due to (AI based) digital technologies, while "core" roles and tasks will continue to exist in the future, some will not be performed by humans but by AI-based technology. For other "new" roles, humans will need to make informed use of digital technologies and, to some extent, collaborate with AI-based technology.

Research limitations/implications – The authors look at the effect of AI-based "smart" technology on the workforce in the broader accounting profession, taking an intrafirm perspective.

Practical implications – This article ties in with current debates on the digital transformation of society and the consequent work changes. Using an AI-based accounting context, the focus of this paper is on the new and adapted roles and tasks.

Originality/value – The comprehensive analysis based on the Delphi study and expert workshops provide ample innovative ground for future research on the impact of AI on organisations and society.

Keywords Artificial intelligence, Accounting profession, Digital accounting, Delphi study, Roles

Paper type Research paper

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Introduction

Digital technology is changing workplaces and workflows in the broader accounting profession (Fawcett, 2015; Guthrie and Parker, 2016; Kruskopf *et al.*, 2020), creating new opportunities and demanding different and advanced technological skills from employees (Greenman, 2017; Lehner *et al.*, 2019; Neely and Cook, 2011). Changes based on new technologies (i.e. enterprise resource planning systems or accounting information systems) are not new and are part of an ongoing process in accounting (Chen *et al.*, 2012; Skrbiš and Jacqueline, 2019; Zeff, 2003). Yet, these current developments are considered to be particularly rapid and drastic because of various market and regulatory forces that are simultaneously driving this change (Hajkowicz *et al.*, 2016). New technologies – especially artificial intelligence (AI) based – will have a major impact on the overall structure and processes in accounting and thus massively transform existing professional occupations and task profiles within a very short time (Neely and Cook, 2011).

Software robots (robotic process automation [RPA]) have already taken over routine tasks (Cooper *et al.*, 2019) and are gradually providing more and more support in non-routine tasks that require decisions on complex and novel situations and flexibility (Autor and Dorn, 2013; Autor *et al.*, 2003; Frey and Osborne, 2017) leading to a higher accounting efficiency (Guthrie and Parker, 2016). In the future, these "smart" AI-based software robots will also be in charge of highly complex tasks such as fraud detection and liquidity planning (Brynjolfsson and McAfee, 2014; Skrbiš and Jacqueline, 2019), improving the effectiveness of accounting organisations. We already see the first steps as AI allows speech and image recognition and learns independently from new cases (Berger and Weidinger, 2018; Najderek, 2020). In the long run, AI-based accounting software will be capable of performing tasks that normally require human intelligence (Huttunen *et al.*, 2019) empowered by highly sophisticated algorithms bringing with a plethora of yet unresolved questions concerning their impact (Hrazdil *et al.*, 2019; Kellogg *et al.*, 2019; Martin, 2019).

Currently, the use of AI-based digital technologies is in its infancy; nevertheless, in a large-scale study on the future of digital accounting, Lehner *et al.* (2020) found that this development will stepwise proceed towards a "Fully Autonomous Accounting System" (FAAS) and described that a

> FAAS is a firm-wide, fully autonomous, self-aware and self-improving accounting system. The centre of an FAAS is a state-based, multi-functional, deep-learning network as artificial intelligence (AI) that is able to holistically simulate and potentially outpace human-cognition and decision-making processes. This AI manages structured and unstructured data and regulations from various sources and delivers timely and apt information to the right audience in the right format (Lehner *et al.*, 2020).

Even if the scenario of an FAAS is still in the distant future, AI-based digital technologies most certainly have the potential to transform occupational fields as well as accounting-related tasks (Bauer and Hofmann, 2018; Diller *et al.*, 2020; Lehner *et al.*, 2019; Marrone and Hazelton, 2019; Moll and Yigitbasioglu, 2019). As a result, the broader field of accounting, in which highly qualified, knowledge-based services [1] are provided and which represents an important occupational field for many people, is undergoing radical changes. Frey and Osborne (2017) predict that 94% of accounting professional occupations could be replaced by AI-based digital technology within the next 10 years. Although this is not yet apparent and contrary to Frey and Osborne (2017), the existing literature does not assume that all humans as knowledge workers will be replaced (Pettersen, 2018), but rather that the professional occupations will be transformed with new AI-based tasks.

This study builds on Sutton *et al.* (2016) who stated that *"researchers also have a responsibility to step back and consider the ramifications for the future of accounting professionals, the accounting profession" (p. 70)*. Further, Moll and Yigitbasioglu (2019)

examined the impact of digital technologies and highlighted the need for further studies to understand new requirements in accounting and to pay attention to changes and new tasks as well as the skills needed (Moll and Yigitbasioglu, 2019; Oesterreich *et al.*, 2019).

In recent years, technology and digitalisation as co-designers of the future of work have again moved more into a labour research focus (Bogedan and Hoffmann, 2015; Kuhlmann and Schumann, 2015). Various perspectives have evolved, such as the focus on technology and its potential to change work and tasks (Brynjolfsson and McAfee, 2014) or newly emerging forms of work (Baruch, 2000; Shockley and Allen, 2007). Thus, this study focusses on the roles and task of human or AI-based actors in accounting based on a large-scale Delphi study and more specifically enquires about the changes in tasks as well as related skills in existing professional occupations in accounting through subsequent expert workshops on AI-based digitalisation.

To explore the roles and tasks of human or AI-based actors as well as skills for professional occupations in an AI-based accounting context, we have chosen a qualitative approach with an explorative study. With the Delphi study and subsequent expert workshops, in-depth insights can be derived and at the same time, different perspectives and experiences of the experts can be considered to achieve valid results.

Our study makes two main contributions. First, we add knowledge to the growing literature on the impact of AI-based technology on the accounting profession in terms of providing an actor-specific view of changing roles and tasks (see also Diller *et al.*, 2020; Oesterreich *et al.*, 2019). Second, and as a practical contribution, we make the future of an AI-based accounting more tangible for management, the individual employee and last but not least to accounting students by identifying the impact of AI on accounting professional occupations and related tasks and skills.

Literature review

Digitalisation is considered one of the biggest and most lasting changes in today's society, which already affects many areas of our lives. Robots and AI assistants have become ubiquitous and are changing the way we work and live at an increasing speed. "Digitalisation", a term that has been around for some time, has now been increasingly replaced by "digital transformation", sometimes even associated with "technological disruption" (Cong *et al.*, 2018) or "digital disruption" (Marrone and Hazelton, 2019) and even "technological (digital) revolution" (Brynjolfsson and McAfee, 2011; Loebbecke and Picot, 2015; Pan and Seow, 2016), signifying an even more societal than technological dimension.

What exactly digitalisation means is complex and not clearly defined (Vial, 2019; Warner and Wäger, 2019). It often refers to the digital networking of different areas and players (Bouée and Schaible, 2015; Hansen and Sia, 2015; Tan *et al.*, 2015), the digitalisation of overarching processes (Bowersox *et al.*, 2005), the use of digital technologies for a wider reach or the reorientation of companies or even the disruption of markets and existing goods and services (Pavlou and El Sawy, 2010; Vial, 2019). In accounting, for example, integrated systems (Galani *et al.*, 2010), software robots (Cooper *et al.*, 2019), cloud solutions (Huttunen *et al.*, 2019), blockchain technology (Bonsón and Bednárová, 2019; McCallig *et al.*, 2019) and AI and further smart digital technology (Greenman, 2017) changed or will change the workflow and processes of accounting (Diller *et al.*, 2020; Susskind, 2017) in the future (Diller *et al.*, 2020; Marrone and Hazelton, 2019; Oesterreich *et al.*, 2019).The future of automation in accounting could be seen in the increased use of self-learning AI-based integrated systems, which access actual data in real time and, based on this, independently develop solutions, suggestions, forecasts and trends (Najderek, 2020).

In addition to the possibility of automating work processes, digital technologies create and allow to make use of vast amounts of complex and timely data. Companies use the data generated by digital technologies to increase efficiency as well as accuracy in accounting

(Loebbecke and Picot, 2015; Schallmo and Rusnjak, 2017). The AI-based work transformation in the field of accounting is therefore not only driven by the possibility to automatise work processes, which already happened over the last decades, but it is also largely driven by the availability of big data (Cockcroft and Russell, 2018; Green *et al.*, 2018; Vasarhelyi *et al.*, 2015) and the use of smart big data analytics. This would allow to predict the future and have the potential to suggest decisions or – in the long run – could replace human decision-making (Loebbecke and Picot, 2015; Marrone and Hazelton, 2019). Therefore, the digital transformation of accounting work brings with that not only simple, repetitive activities but highly intricate cognitive work is taken over by AI-based technologies and well-paid jobs may no longer exist in the present way (Loebbecke and Picot, 2015).

Historically speaking, revolutionary technological progress has always resulted in major reorganisation of global socio-economic systems (Fujita, 2018; Wright and Schultz, 2018). Since the industrial revolution, progress and technical innovation have transformed numerous manual tasks and processes, activities that reached the limit of the physical capacity for humans to perform (Fujita, 2018; Wright and Schultz, 2018). It stands to reason that AI will one day perform at least at the capacity of human brains in various service professions (Fujita, 2018). This of course also proposes challenges for the accounting profession at large (Carter *et al.*, 2015; Ramirez *et al.*, 2015; Vinnari and Dillard, 2016) and in particular to research in accounting (Guthrie and Parker, 2016), especially from a critical (Gendron, 2018) and contextual standpoint (Alles, 2020; Lowe *et al.*, 2020).

Research has so far focussed mostly on the effects of the use of (AI based) technologies on singular roles in accounting (Diller *et al.*, 2020; Moll and Yigitbasioglu, 2019; Oesterreich *et al.*, 2019) but never on the whole of the accounting profession. Of particular importance for this contribution are the dimensions of *roles* (human–robot collaboration and interaction), *tools and skills*. With AI-based digital technologies, activities change as people use and communicate with these working tools, thus creating new routines while autonomous working tools gradually take over certain areas of activity. As a result, activities will shift and people will require different (new) skills and qualifications. It is precisely at the interface of these dimensions that our contribution starts because ultimately, the questions are which human work activities are transferred to AI software or robot, how coordination and division of labour take place in this and whether this results in possibilities of relieving or even substituting the workforce (Bauer and Hofmann, 2018).

Previous research has also focussed on accounting and the automation of processes, data processing and data quality (Ghasemi *et al.*, 2011; Güney, 2014; Taipaleenmäki and Seppo, 2013). With regard to the concrete effects of digitalisation on the accounting department of companies, one key point derived from the literature is the increased networking of people and software robots, both within the company and with customers and suppliers and the associated higher data pool for financial decisions (Marrone and Hazelton, 2019). Furthermore, the accounting departments will have even more responsibility for handling and using data (Oesterreich *et al.*, 2019; Pfizenmayer, 2016) and efficiency gains can be expected from analysis tools in planning and forecasting (Brynjolfsson *et al.*, 2011; Vial, 2019).

Identifying a polarisation, Autor and Dorn (2013) state on a general societal level that tasks with either high or low qualification requirements will be even more prevalent in a digital future because digitalisation will primarily impact and replace tasks with medium qualification levels, still leaving room for low qualified employees. However, and perhaps more suitable for accounting, there is the alternative thesis of an overall increase in the qualification levels within the profession due to a rise in complexity and potential opportunity (Oesterreich *et al.*, 2019; Zuboff, 1988). We already see that simple tasks will be automated in accounting, and thus, higher-qualified activities will be expanded. At the same time, the use of digital technologies will increase the quantity and complexity of data requiring highly qualified employees (Hirsch-Kreinsen, 2015). The accounting already provides many

qualified jobs, and it can be safely assumed – as later also confirmed by the participants in the focus group of this study – that the qualification level and the demands on employees will continue to increase even more within an AI-based accounting (Marrone and Hazelton, 2019; Mayr *et al.*, 2016; Oesterreich *et al.*, 2019). It is not only the management level but also the employees that play important roles in the implementation of digital technologies and the operation of these in complex settings with a high demand on interaction between different systems (KPMG, 2019). Consequently, it seems important to mention that insufficient qualifications on all parts of the accounting workforce are regarded as major barriers to the adoption of new technologies in companies (Oesterreich *et al.*, 2019).

In summary, accounting will be subject to changes in the use of new (smart) technologies and big data which will require different tasks and the upgrading of the qualifications as well as new forms of collaborations and interactions (in particular human–machine interactions). This provides us with an exceptional opportunity to develop a future scenario of the tasks and skills of intrafirm professional occupations in accounting. In the following, the methods chosen for data collection and presentation of the results are described.

Methodology

In order to answer the research question, we opted for a two-step exploratory approach for our empirical research. Using a large-scale Delphi study over three rounds with 138 globally distributed respondents, we first identified roles and tasks in an AI-based accounting of the future. These were then allocated to AI and/or human actors in professional accounting occupations in subsequent expert workshops. The methods and the research process are explained in more detail in the following sections.

Sampling and the Delphi method

Following Okoli and Pawlowski (2004), we used the Delphi method to collect data on assessment of the financial sector in 2030 from a large group of participants acting as expert panels. The Delphi method is described in the literature as being particularly relevant to "forecast and identify issues" (Gallego and Bueno, 2014).

We worked with 138 interviewees during three rounds over the course of two years (2018–2020). The interviewees were selected from the member database of the global ACRN Oxford Research Network on Accounting, Finance, and Risk (http://www.acrn.eu). From the 1,740 professionals selected, based on either being a scholar with a doctorate or a practitioner with more than three years at a managerial level, we received 138 answers. Table 1 provides some insights into the composition of the interviewees.

We started in the first round by asking about the future of accounting, current and future roles and tasks and the impact of digitalisation in 2030. The study deliberately set the time frame up to 2030 as the possible digital developments in particular for AI-based digital technologies appear to be predictable within this time frame.

Criterion	Characteristics
Location	Europe: 38% North America: 22% Asia: 20% South America: 8% Africa: 8% Australia: 4%
Age	Average 34 years, SD of 6
Gender	52% women, 48% men

Table 1.
Composition of the interviewees

We considered the answers from all of the respondents, clustered these into overarching topics and discussed these during a series of half-day workshops with the help of two research assistants to enhance the qualitative validity.

Summarising the topics wherever possible based on the convergence and making explicit the remaining areas of contestation, we then contacted the interviewees again and asked them to add, delete and clarify where appropriate. After three iteration rounds over a period of two years, we reflected back any idiosyncratic longitudinal changes in the expectations of our participants and asked them to comment on what made them change their minds. This provided us with further insights into the nature and impact of the ongoing discourse of digitalisation in accounting and how competing discourses gradually converged over time.

Expert workshops

Within the framework of expert workshops, a focus group of 30 experts, consisting of eight academics and 22 practitioners from various fields of accounting as well as auditing, discussed and further developed the results of the Delphi study.

The found roles and tasks from the Delphi study were then discussed during the expert workshops. Using small focus groups, the experts developed drafts of existing and new professional occupations in AI-based accounting and allocated said roles and tasks to actors. The commonalities and significant differences between the drafts were discussed and individual statements of experts on the results were drawn up. Conclusions on AI or human-based actors for these occupations were finally drawn in the final focus group.

Findings

Core roles and actors in an AI-based accounting

From the Delphi study, we see that cloud computing and blockchain technology are drivers in technological empowered accounting. Our findings show that AI-based technology will have the biggest impact on roles and tasks of accounting employees. AI-based technologies such as smart robots, automated feature tools and business intelligence (BI) tools have the power to replace humans as an actor and change processes in accounting.

The findings of the Delphi study provide insights into the roles and related tasks in an AI-based digital accounting and to what extent and for which roles agency was conferred upon AI actors. We identified eight core roles of the accounting in the year 2030, which were derived inductively during the Delphi study. In total, five roles of the eight roles already exist and three might be completely new in an AI-based accounting. Summing up the insights from the Delphi study, Table 2 displays the roles and tasks and connects these to the carrying actors (human or AI-based technology) in accounting nowadays and in 2030.

As shown in Table 2, AI-based technology will replace human employees in routine tasks using, for example, smart software robots to perform routine tasks such as recording and collecting data. Furthermore, AI-based technology might be a co-actor by suggesting decision options, thus supplementing human actors. However, there are tasks that will be done exclusively by humans. In AI-based accounting in 2030, humans will train AI-based technology and use their expert knowledge and experience to monitor AI-based technology. At the end, the core roles of humans are to ensure and being responsible for an effective and efficient collaboration of AI-based technology and humans to fulfil the roles of accounting.

Roles, tasks and skills of professional occupations in an AI-based accounting

After having identified the core roles and tasks in future accounting, we focus on the question of how the tasks and skills connect and potentially change existing and new professional occupations. During the expert workshops, we analysed the following professional

Table 2.
Roles, related tasks, human and AI-based actors in accounting

Roles: tasks / Actor	Current actors	Actors in the year 2030
1. Transaction recorder: recording transactions, posting to account and reconciling and balancing accounts	*Humans* screen documents, post them to the correct account and manually reconcile and balance accounts supported by software tools (for example, booking software)	*AI-based technology* (for example, a smart software robot) which extracts information from machine-readable digital data formats as a self-learning system, posts it to the correct account; *humans* will supervise the results and take care of exceptional cases the AI-based technology is not able to solve
2. Data and information manager: collecting and selecting data for information gain	Due to their expertise, *humans collect and select* the data used for valuation, forecasting, risk mitigating . . ., they use mainly internal data from historical transactions and/or selected external structured data	Free data exchange standards enable *AI-based technology* such as automated feature tools to collect and suggest internal/external and unstructured/structured data relevant for the task; *humans* decide about the usage and/or *supervise* the selection of data
3. Data miner: data mining (analysing) to optimise costs, generate sales, forecast, mitigate risk or detect fraud and guarantee compliance	*Humans* fulfil this role by analysing mainly historical internal structured data using spreadsheets and descriptive analytics	*AI-based technology* (such as business intelligence tools) uses predictive analytics tools to analyse and recognises anomalies, interrelations, trends and patterns within big data; *humans* can *focus on major incidents*
4. Dashboard designer: reporting and visualisation of data	*Humans* use software tools (such as Excel, PowerPoint) and standardised formats to report and visualise the data on a regular basis	*Humans* design interactive dashboards with AI-based tools, which meet the needs of the user in an iterative way in nearby real time

(*continued*)

Table 2.

Roles: tasks Actor	Current actors	Actors in the year 2030
5. Advisor: interpret the data and decide or advise/ communicate to stakeholders	*Humans* interpret the data due to their individual experience in the field	*AI-based technology* suggests data-driven decision options based on prescriptive analytics, *humans* interpret the AI outcome and understand the overall engagement process and have to weigh up options and decide or communicate to stakeholders and advise due to their expert knowledge and experience
6. AI technology expert: training and supervising AI-based digital technologies	*Not necessary right now*	*Humans* train and supervise AI-based technologies, such as a trainee, in a specific task and how to interact with humans to provide human and AI-based technology collaboration
7. Process manager: selecting processes for automation and the corresponding AI-based technology or components	*Not necessary right now*	*Humans* using AI-based process mining tools identify processes for automation, select the relevant AI technology or component and make sure that the collaboration of AI-based technology and humans work
8. Legal and ethical supervisor: guiding and monitoring legal and ethical requirements	*Not necessary right now*	*Humans* are responsible to guide AI-based technology and monitor whether the data-driven decisions made by humans meet legal and ethical requirements

occupations: bookkeeper, accountant, controller (management accountant), business data analyst, treasurer and risk manager and financial systems and process manager.

Bookkeeper

Currently, bookkeepers perform daily accounting tasks. They make journal entries for the (paper) invoices and receipts, payments and other documents concerning financial transactions. In many companies, bookkeepers manually read the non-machine-readable portable document formats (PDFs) for the required information, put the data into an accounting system and post them to the correct account. Furthermore, the bookkeeper is responsible for storing paper and digital files. At the end of the month, it is necessary to reconcile and double check the accounts and to re-code a transaction if necessary. Bookkeepers are also expected to handle customer and supplier account queries, invoices and payments. Additionally, it is the task of the bookkeeper to contact customers in the case of overdue accounts and arrange the next steps.

The findings show that the demand for bookkeepers doing routine tasks will be much lower in 10 years due to extensive enhancements in the use of digital technologies. In the future, most companies will use business-to-business (B2B) transactions, a worldwide used digital data exchange format or AI-based technology, such as optical character recognition (OCR) technology, and provide digitalised invoices to consumers. Machine learning algorithms will categorise and interpret the digitalised data and post them to the correct account. Furthermore, smart bots are used to reconcile and make checks to avoid accounting errors. To guarantee compliance and that only authorised people can read the files, the digitalised data are set with a permission and every action is tracked in an audit trail, which improves the transparency. Thus, smart software robots will not only automatise tasks but also improve the quality of financial data by AI-based checks.

The bookkeeper will then be responsible for ensuring that all business transactions are accounted for by smart accounting software. We also found that all bookkeepers will take a key role in the implementation phase of AI-based accounting software. As the AI is a self-learning system, the bookkeeper's task is to train the AI according to specific user needs. After a successful implementation, the bookkeeper will intervene in special cases when the digital technology is not able to process. Furthermore, it is vital to ensure that processes are adapted to changing business models/processes or accounting regulations. He/she will support the manager for financial systems by providing domain know-how and performing checks during the implementation phase of new AI-based software robots. As P1 stated: *"What will really be left for bookkeepers? There may be a lot taken over by robots. It is quite possible that the focus will be on taking care of incidents"*. P2 also expressed what is probably a widespread fear: *"These robots would probably already reduce the workload and time pressure, but I'm not sure if I still meet the expectations of a bookkeeper"*.

In terms of skills, our findings show that it is becoming increasingly important for bookkeepers to have a broader domain know-how, information technology (IT)-user skills, better problem-solving competences and an understanding of processes. P3 pointed out: *"Building up these skills will certainly be a challenge that companies as well as all educational institutions will have to face, but not least the employees concerned will also have to face it"*.

Financial accountant

We also see that intercompany reconciliation work, collecting information for the valuation of assets and liabilities or the preparation of reporting elements, which currently are tasks of the financial accountant, will be performed by AI-based digital technology in the future. Our participants also agree that accountants will use new sources of data (for example, Internet of Things [IOT] or drones) for the valuation of assets and liabilities. P15 considered that

"Even though we have access to Big Data, people still have to determine which data is used for the valuation". P3 stated: *"I assume that the complexity of regulations will increase due to Big Data in accounting, e.g. regulators should also determine which data may be used in order to still guarantee comparability and transparency"*.

In times of increasing regulations and new or changing business processes, the accountant also takes care that the financial accounting systems map these correctly. The challenge will be that *"Accountants will be involved in multiple processes" (P4)*. P3 summarised this development as follows: *"Even if the software is able to process the tasks, the responsibility for the tasks and the content of the financial report remains with the 'physical' accountant"*. The financial accountant will therefore be responsible for automated reporting, monitors and audits to ensure compliance with corporate governance and improve data quality.

Accountants will also have to deal with complex issues that need to be interpreted in terms of accounting requirements. He/she is expected to be supported by self-learning AI-based legal expert systems with speech recognition interfaces. Aside from "human" colleagues, there will be "virtual" colleagues who will support decision-making and guarantee a dual control principle. Advanced natural language processing will enable dialogue in human language, making it difficult to distinguish whether we communicate with a physical or virtual colleague. As P6 said, *"The (tax) accountants' main task will be to identify optimal solutions for the company (. . .) even at the risk of accepting the virtual colleague's suggestion without reflection"*.

We also see that expertise and a strong personality will be important to weigh up to what extent the accountant is willing to rely on the decision of the expert system. P17 concluded: *"In addition, virtual colleagues will support us in making decisions and only guarantee a dual control principle"*. P3 considered: *"Even if expert systems help us and show us solutions to our problems, it is our task to make the right decision. To understand, the decision of the expert system, the traceability of the AI's decision will be an essential criterion"*. In an AI-based accounting domain, an understanding and knowledge of accountant's business ethics is required to assess whether the AI-based suggestions comply with accounting standards and ethical principles.

The accountant will still communicate with the authorities and auditors and clarify possible deviations and necessary system adjustments in the future. In terms of single point of truth (SPOT), it is essential that the financial accountant, as a data provider, also exchanges data with other departments, such as treasury. Furthermore, P1 explained: *"The accountants will be the important interface to authorities and auditors"*. P25 summarised the following: *"In AI-based accounting, the accountant still provides data that meets legal and ethical principles"*. To fulfil these tasks, good accounting and business ethics knowledge, an understanding of how the AI makes its decisions, communication skills, process management skills and IT-user skills are prerequisites.

Controller (management accountant)

In an AI-based accounting, controllers are increasingly emerging from their pure information provider role and developing into business partners. Just like today, there will not only be one single controller role. Depending on the organisation, there are business or group controllers as well as controllers for certain business functions (e.g. sales controller, production controller, R&D controller).

P1 underlined this as follows: *"Controllers do extremely different things, depending on the company size and type. Their tasks will remain diverse and important. Above all, working with data and processing the data will also be strategically important in the future"*.

The task profile of the controller will change mainly due to the increasing amount and variety of data (Bhimani and Willcocks, 2014; Krumwiede, 2016) and will combine the skills of a business partner with the understanding of data analytics. The use of digital technologies will enable controllers to position themselves strongly as management partners in the future

and thus make a significant contribution to the sustainable success of the organisation in accordance with the mission statement of the International Group of Controlling (IGC, 2013).

"The controller is becoming a consultant. He knows the figures very well and can draw the right conclusions" (P7). This requires advanced methodological skills to understand AI-based analysis, forecasting techniques and data visualisation. Digitalisation in this role will primarily affect the area of management reporting with a strong focus on process optimisation using process mining tools, the design of perfectly visualised interactive dashboards and decision support based on big data. For the implementation of dashboards and the deep dive into the data, the controller will be supported by the specialised data analyst.

In the field of operational planning, processes will be optimised based on workflow tools. The traditional annual budget will be supplemented and, in some cases, even completely replaced with rolling forecasts. In AI-based accounting, prescriptive BI tools, which are set up by the business data analyst, provide simulations to improve the efficiency and accuracy of plans and forecasts and will suggest scenarios. In the future, controllers will focus on selecting the right scenario and supporting the management team in strategic planning and investment decisions.

Business data analyst

In the past, data analysis was often based on expert knowledge and simple descriptive analyses. In many cases, in accounting, this role was performed by a controller, treasurer or risk manager. In the future, the one making the deep dive into the data will be the business data analyst. Business data analysts will work in the respective specialist area such as accounting. P18 summarised that *"Data analysts will create analysis and visualise it in a user-optimised way"*. P7 explained: *"The business data analyst is the person responsible for Big Data and analytics in accounting"*. He/she needs a domain knowledge and knows the internal (financial) data as well as external sources for benchmarking purposes. BI tools help him/her to analyse the data, discover patterns and trends and draw conclusions about a hypothesis. Therefore, it is necessary to feel comfortable with coding languages such as *R*, Python, MATLAB or SAS to adapt existing codes and to have basic knowledge of algorithms and data structure. Nonetheless, P15 said: *"The data analyst will not make the choice for the algorithm the tool uses; this task will be performed by mathematically-statically trained data scientists, which work in the data lab department of the company"*.

In accounting, he/she supports the controller/treasury and risk manager with dashboards, which visualise the data in the most effective way. Even if he/she provides and visualises the necessary data, he/she is not directly involved in strategic work and is not responsible for the communication to management. P3 stated: *"He/she is the data nerd, presentation and communication skills are not the most important skill for the business data analyst"*. P18 said the following: *"The work of the business analyst will be systemic analyst work"*. Therefore, analytical thinking and innovation are required to provide new possibilities and ideas regarding the data. Furthermore, reliability, curiosity and willingness to learn will be required. P21 stated that *"Willingness to learn is a very important characteristic of a data analyst because tools, methods, and new technologies are subject to a continuous change. Continuous training will be necessary"*.

Treasurer and risk manager

Treasury and risk management is also becoming increasingly important for the success of the company due to the increased use of big data, the constantly changing economic framework conditions and newly emerging financing instruments. The most modern techniques and software solutions are used in this area to ensure the most accurate and efficient planning possible.

Treasurers and risk managers are professional occupations that have already been around for some time now (although still new compared to, for example, accountants).

However, the tasks these professional occupations now need to fulfil have changed dramatically over the years because treasurers and risk managers need to be all-round talents for all things' liquidity. Recent developments concerning legal requirements and reporting duties (see, for example, EMIR or PSD-II) make it almost impossible to fill this role without integrated treasury management systems (TMSs) that increasingly relies on AI to automatically predict regulatory actions and check for compliance. What is more, so called RegTechs (AI-powered regulation modules) create all necessary report templates and communicate with the authorities in the background.

While current tasks, such as long- and short-term liquidity planning, hedging, credit monitoring or communicating with financial markets were seen by the participants to remain, we identified new tasks that will be more prevalent in the future, including compliance with trading regulations, continuous, AI-based liquidity forecasts with scenarios, support of internal fraud detection systems (with the compliance manager), customising and monitoring automated AI-based liquidity steering, supporting short-term bonds and debentures emissions in online auctions based on blockchain technology, customising, testing and constantly updating the RegTech modules and creating highly customised liquidity reports for self-service insights on intranet dashboards with the use of high level programming language and tools.

P12 said the following: *"I could not imagine running all the tasks as single treasurer without the sophisticated AI-based RegTech system. It does identify all trading related reporting needs and communicates with authorities with a simple click of the mouse"*.

In addition, P3 further stated the following: *"Sometimes it feels as if you are flying on autopilot. All you do is check for red signals but how and what is happening under the hood has become so complex (and changing with every software update) that I am having a hard time understanding which robot now does what and when. It feels I am merely the janitor of my machines, yet I am accountable for what happens"*.

This is also well reflected in the data as many participants understand the constant connection to the processes via smart tablets as the new normal, giving them freedom but also burdening them outside of normal office hours. The complexity was universally seen as highly problematic, leading to a previously unknown level of operational risks that is sometimes not visible in traditional risk calculations.

In addition, P40 exclaimed: *"All these recent changes have brought with the necessity to constantly update our skills, my older colleagues sometimes struggle to cope with the sheer pace of change. Yet, treasury and risk management has always been highly dynamic so that overall, it has become part of the job to annually invest in approximately 10 days of training"*.

This complexity also has its advantages. P20 stated the following: "*Script kiddies and so-called Data Scientists can never take over what I am doing. Besides the need to be open to the latest technology and constantly adapting your computational skillset, the most important part remains the domain know-how, from legal and regulatory aspects to understanding how in-house business decisions will affect liquidity. Together with being able to talk to – and be respected – by all departments and subsidiary leaders, this combination of business know-how, technological savviness, and soft skills make our jobs unique and well paid"*.

Financial systems and process manager

Selecting (AI based) technology or components will be a "core" role in the finance and accounting department. The responsible manager will act as a coordinator for digitalisation and automation initiatives. He/she will identify processes for AI-based digitalisation using AI-based process mining tools and in coordination with the process owner (bookkeeper, financial accountant, controller and treasurer and risk manager). Furthermore, the financial systems and process manager evaluates the effectiveness and efficiency of enhancements through AI-based technologies and prepares cost/benefit calculations and ensures

compliance with ethic principles for decisions on their implementation. Using the example of reporting, P27 argued that process automation must not be an end in itself: *"Automated reporting should not only enable timely reporting, but also improve the quality of reporting"*.

The financial systems and process manager, in close cooperation with the human resources (HR) department, assures that employees develop the necessary skills and competences to use AI-based technology and enable collaboration between humans and AI-based technology. *"These people need a very broad skill set because they will be working in different areas of accounting. At the same time, they also have to make sure that the skill set of the employees fits to cooperate best with AI and participate in the digital transformation process"*. (P5)

In addition, the financial systems and process manager is responsible for authorisation concepts, AI-based robot management and quality assurance and works with the IT department on applications and data storage in the cloud, interface programming and IT security. Following P1, the responsibilities must be clearly clarified. *"In the future, the main question will be the following: What does AI do and what does the accounting department do? This will overlap and must be well coordinated"*.

The position of the financial systems and process manager is very challenging and requires comprehensive skills, in particular the willingness to understand and deal with new technologies, communication skills, a holistic understanding of processes, basic accounting knowledge (to understand processes) and project management skills. Moreover, he/she needs soft skills such as motivational capabilities and empathy to get everyone involved in the implementation, overcome obstacles and drive projects forward successfully.

Conclusion

In our study, we observed that severe and foreseeable disruptions in future AI-based accounting may lead to new roles and tasks and thus, opportunities for actors – just as scholars have recognised this trend throughout history (Acemoglu and Restrepo, 2019). We then continued to discuss the potential impact on the existing accounting professions in expert workshops, paying especial attention to human or AI-based agency. Looking at the findings from a purely functionalist standpoint, AI will also bring about an increased need for highly skilled workers (Wright and Schultz, 2018), and it may also create as many jobs as it replaces, thereby opening up several excellent employment opportunities (Acemoglu and Restrepo, 2019; Barro and Davenport, 2019). Our findings thus contradict the prevalent notion that AI as an actor is going to replace human actors and rather recognise that AI is going to collaborate with humans and supplement human decision-making, instead of replacing it (Agrawal *et al.*, 2019).

Based on the expert workshops, companies must also learn to implement and use AI correctly and ethically. Using AI to drive innovation and enhance traditional roles will boost their productivity and overall employment rather than reducing it (Bughin, 2018). AI's greatest impact will, thus, not come from replacing jobs with new technologies but from changing what people do. Therefore, it is the company's responsibility to adopt AI in a continuous learning cycle and position itself for growth (Bughin, 2018). With our insights on the individual professional occupations, roles and tasks, we hope to contribute and show potential ways forward and propose the questions that need to be asked from a broad accounting research perspective.

From an organisational and teams perspective on AI-based accounting, that includes algorithmic and big data considerations, we might ask in future research

(1) To what extend should AI-based robots be given agency and what are the ethical boundaries in an AI-based decision-making process?

(2) How can we cope with individual and collective fears and prevent a possible "digital divide" in the workforce in accounting? (Marrone and Hazelton, 2019)

(3) How can we organise effective, efficient and agile accounting structures, processes and teams that transcend geographical and cultural boundaries? (Brynjolfsson and Hitt, 2000; Cooper *et al.*, 2019; Vial, 2019)

(4) How will we effectively collaborate and communicate within heterogenous and disclocated, mixed AI and human accounting teams and external (artificial) partners (e.g. chatbots)? (Diller *et al.*, 2020; Marrone and Hazelton, 2019; Dolan *et al.*, 2015)

(5) What is the role of trust in our interactions with AI-based robots in accounting: is AI's legitimacy potentially too high and are we trusting it perhaps too much based upon wishful thinking and too little actual knowledge? (Glikson and Woolley, 2020) Human trust in Artificial Intelligence: Review of empirical research. *Academy of Management Annals, forthcoming*)

It is not possible yet to assess the net effect of AI on work as a whole, but it became clear in our study that a new human–machine symbiosis appears to be on the horizon in a future that requires critical and continuous insights from research (Gendron, 2018; Palea, 2017). The future accounting team might be even more characterised by its networking, both within people and between people and AI and by openness, flexibility and interdisciplinary thinking and working. Therefore, the early anticipation of changes by implementing digital technologies and ensuring that future employees have the necessary qualifications to handle these technologies is an essential prerequisite for a continuous, successful change process in the field of accounting (Berger and Frey, 2016; Pan and Seow, 2016).

Notes

1. The financial sector is understood here as a knowledge-based service since according to NACE Rev.
2. The accounting and management of enterprises are included in the section of "Professional, scientific, and technical services".

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