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EDITORIAL

THE WHATNESS OF DIGITAL ACCOUNTING: STATUS QUO AND WAYS TO MOVE FORWARD

OTHMAR LEHNER[1], SUSANNE LEITNER-HANETSEDER[2], CHRISTOPH EISL[2]

[1] University of Applied Sciences Upper Austria and Hanken School of Economics, Helsinki, Finland
[2] University of Applied Sciences Upper Austria

Introduction

Digital Accounting has found its way into the everyday language used by accounting practitioners, with the Big 4 auditing companies pouring massive resources into the digitalisation of accounting processes in order to create an early-mover business advantage.

In research, digital accounting is used as summarizing term for a variety of research endeavours into the digitalisation and automatization of accounting processes based on emerging technologies (Quattrone, 2016). The existing literature deals for example with the role of digital technology in accounting and reporting (Güney, 2014; Ghasemi et al., 2011; Taipaleenmäki and Ikäheimo, 2013), the integration of the competences required in the accounting curricula (Sledgianowski et al., 2017; Janvrin and Weidenmier Watson, 2017) and the detection of fraud (Pearson and Singleton, 2008).

Already by its name, a research field of digital accounting will have to be interdisciplinary, as it includes the disciplines digital (information) technology and accounting (Lehner and Martikainen, 2019). However, due to the broadness of accounting itself, comprising financial as well as management accounting (Taipaleenmäki and Ikäheimo, 2013), insights and theories from these subfields as well as from auditing, innovation and engineering, business law, organizational theory and ethics as well as accounting education amongst others, will provide further fruitful avenues to enrich the field of digital accounting.

While this variety of related fields and theories and the related insights from particular angles certainly provides value and drives the field forward, a common, holistic understanding of the *whatness* of the field of digital accounting and a related research agenda that would allow to join forces and interlink the various perspectives is missing so far.

In the past, *accounting information systems* (AIS) have changed the way that data is collected and prepared for the decision-making by stakeholders (Neely and Cook, 2011). The further development of such systems, for example through partly-autonomous robots for process automatization, through advances in creating fully digital workflows and finally also innovative algorithms based on data-science certainly form a major part of how digital accounting needs to be understood in current research. However, most scholars would agree that digital accounting in the future will certainly be more than just collecting and processing data, as advances in *artificial intelligence* (AI) research already predict some sort of multi-functional, cognitive capabilities and the ability to make decisions given complex scenarios. Therefore, digital transformation in accounting needs to be seen as an ongoing process that ultimately may lead to a *fully autonomous accounting system* (FAAS), which will be defined later in this paper. Such a fully autonomous accounting system would include (AI) based cognition and high-level decision making as special and new areas within the wider field of accounting. Of course, such developments are necessarily embedded within a larger societal

change process induced amongst by a variety of technological advancements (Vial, 2019) and societal movements (Colignon and Covaleski, 1991; Englund et al., 2011; Hopwood, 1983).

With this special issue, we thus like to invite and motivate the community of scholars interested in digital accounting to collaborate, to take in the various field-specific perspectives and to finally holistically map and delineate the field of digital accounting. For this, we propose an early framework and a research agenda that may unite and guide researchers towards a holistic understanding of the field.

In addition, and for this special issue we have asked grad-students and researchers from the department of accounting at the Hanken School of Economics, Helsinki to provide their research papers and perspectives on the "whatness" of Digital Accounting.

Utopian Spotlights of a Fully Autonomous Accounting

Here we provide a selection of five spotlights on different aspects of digital accounting to illustrate the insights we have gained so far from an ongoing delphi study on this topic.

Spotlight 1: Extending the customer base

A new customer X in a B2B scenario sends an inquiry for a certain quantity of our top-selling product A. The AI deploys a robot to crawl all external data sources including company-register, company web-site, social-media, banks and triangulates the findings with the response from the credit-agency. The credit-worthiness has been confirmed and starts a price calculation that includes current sales and production-capacities as well as the previously determined credit-risk. The price is confirmed by X and we receive a full order. Immediately, a robot transfers all data from the order as well as the previously retrieved additional data from the crawler into a newly generated customer item within the virtual data store and logs the order into the ERP subsystem.

Spotlight 2: Ad-hoc reporting and decision support

Our marketing manager receives information from a media partner that a top athlete and multiple medal winner would be available for a long-term sponsorship contract. The marketing manager sends an ad hoc request to the FAAS via voice recognition to get decision support. The FAAS assesses the effects of sponsoring on the image values and price willingness of the customers, updates the sales forecast, checks the available advertising budget or suggests budget reallocations and, taking into account a risk assessment, makes a final recommendation on the range of the rationally justifiable sponsoring amount.

Spotlight 3: FAAS-warning message

Early in the morning the production manager arrives at the office and asks the FAAS to provide an internal status report and update in natural language by asking "What's news?". The FAAS scans all relevant real-time reports and data trends and compiles the top news. The FAAS places the focus on a warning message that requires immediate action: "Current machine sensor data indicate urgent maintenance work in a production plant". In the background, the system has already checked possible production shifts to another flexible manufacturing cell as well as outsourcing options and has determined the cost-optimal time for the upcoming maintenance work, taking into account adherence to delivery dates and maintaining a high level of customer satisfaction. The gathered data is presented as a working scenario and potential solution to the manager. After her confirmation, the FAAS automatically initiates the execution of the plan. Based on the severity of this maintenance, the FAAS classifies it as a major inspection

according to current GAAP (generally accepted accounting principles), recalculates the real-time forecasts and updates the top-management reports.

Spotlight 4: Valuation of a Leasing Contract using timely WACC

Our FAAS applies AI for the extraction of lease data attributed from the contracts and for the following classification, valuation and presentation of leasing contracts in the financial reports. In addition to the classification of the leasing contract, several internal as well as external information sources are used by the FAAS to calculate the average weighted capital costs (WACC) for each contract based on the commencing dates and maturity. For this, yield rates based on the maturity as well as current risk-based equity costs are calculated. Because of differences between the various applicable, local and international accounting and taxation standards, the FAAS acts accordingly concerning the classification, recognition, measurement and reporting. The data and underlying set of applied rules is automatically transferred to the contracted auditing firm.

Spotlight 5: Reflecting Strategic Decisions in the Accounting System: The Case of End-of-Life of a major product line

Product line B has seen the best of its days. With a number of product variations and related, then well-crafted cost-centres, line B was among the core lines of the company for a long time. Due to innovation and inevitable changes in the markets, the board has decided to cease line B three years ago and the sales and production transition is now complete. In an attempt to reflect these changes now in the accounting system and to clear it from any remaining clutter, the FAAS has now been tasked to take care of the necessary steps. The AI first takes into account respective regulations for financial accounting and also considers the change in demand for internal information on all levels. All data and features that need to be kept for external regulatory compliance are archived and marked with a due date for deletion, and the internal accounting structure is adapted by marking the cost-centres as obsolete, deleting all related items for possible new entries in the ERP system, adjusting the calculations for the various key performance indicators (KPIs), and by remodelling and optimising the management dash-boards to make better use of the now empty space. It then provides an update to the CFO including how the sales volumes of the discontinued line B have already been successfully transferred to the new lines by the individual customers and creates a list of recommendations for the sales team which customers might need to be better addressed as their current volumes indicate that they have replaced B by alternative products from outside of our company.

Three Maturity Levels of Digital Accounting

Based on our prelimiary literature review of the state of the art, see for example (Taipaleenmäki and Ikäheimo, 2013; Sledgianowski et al., 2017; Kokina and Davenport, 2017; Janvrin and Weidenmier Watson, 2017; Güney, 2014; Davenport and Kirby, 2016; Belfo and Trigo, 2013; Crookes and Conway, 2018; He, 2018; Huang et al., 2018; Robson and Bottausci, 2018), and the derived utopian scenario we now propose an early framework (see figure 1) of digital accounting and subsequently outline its main defining characteristics.

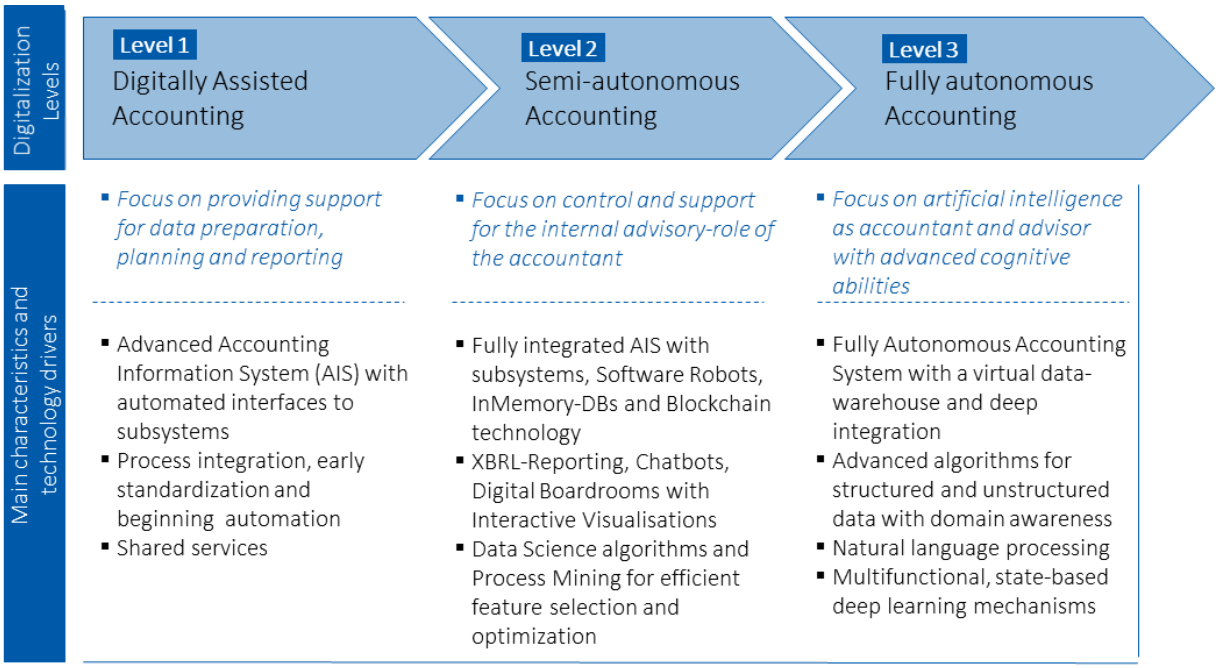

Figure 1 Three maturity levels of digital accounting, source: Lehner, Leitner-Hanetseder and Eisl (2019)

Level 0 (Software Assisted Accounting): In this basic level accountants are assisted in their traditional roles by standard functions of silo-based software applications. Level 0 is characterised by the extensive use of often spreadsheet-based, idiosyncratic softwar and follows predominately paper-based filing and workflows.

Level 1 (Digitally Assisted Accounting): Within this first maturity level of a truly digital accounting, accountants mainly focus on data preparation, company-wide planning and reporting and are digitally assisted by enhanced and in many cases cloud-based accounting information systems, with connections to all major sub-systems (ERP etc.) using semi-automatic interfaces for data translation and transfer. Level 1 is characterised by a mixture of manual and automated document processing, the use of optical character recognition (OCR) for standardized documents as well as by an electronic filing system. Repetitive, standardized processes on a large volume of documents are carried out by (often offshore) service-centres using a mixture of cheap manual labour and simple automatization approaches. The use of software robots is in its pilot phase. Planning, budgeting and forecasting are performed by using a highly integrated software solution with automated management workflows.

Level 2 (Semi-autonomous Accounting): Within the second maturity level of digital accounting, accountants focus on the interpretation of system-generated information and take on a stronger internal advisory-role that is supported by a fully integrated AIS for financial as well as management accounting. This AIS is characterized by high levels of automatization and has advanced data science algorithms implemented. Within Level 2, automated document processing within a fully automated workflow is employed, specialised software robots are used in almost all areas, digital reporting is fully XBLR-based and overall reporting-cycles have been tremendously shortened. The AIS uses In-Memory-database technologies and Blockchain-based distributed ledgers and is connected with social media platforms for financial disclosures and non-financial insights. Process-mining controls and documents all accounting processes. Accountants include external and unstructured data in their enhanced Business Intelligence (BI) solutions and use data science tools to tackle big data analytics, predictive analytics and fraud detection. Early stage AI-powered applications provide human decision makers with high-quality based for decision-making. Managers can retrieve ad-hoc information via Chat bots and use cutting-edge technologies-based devices and digital boardrooms for their meetings and video conferences.

Level 3 (Fully Autonomous Accounting): Maturity level three of the digital transformation focuses on artificial intelligence in an autonomous accounting system, with self-aware cognition and (albeit) limited decision-power. A multi-functional, deep-learning powered AI provides the automated application and adaption of accounting and tax-regulations, implements optimization measures, provides target-audience specific reporting and forecasting in real time, runs simulations and scenarios and issues regular management warnings on major key performance indicators with detailed analyses and recommendations. The AI also controls the deployment of the specialised robots according to the necessary tasks at hand as directed by management. It uses a deeply-integrated virtual data warehouse that includes internal and external data and is fully managed concerning data protection, security and availability. Managers communicate with the system via natural language processing from everywhere. The system improves its own performance by deep learning mechanisms. At this stage the accounting information system (AIS) becomes a fully autonomous accounting system (FAAS). Based on our analysis of the future, utopian scenario, we define such an FAAS as follows:

"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."

Discussing a Research Agenda in 5 Items

We finally combine the insights gained from the literature review with the early empirical findings from the Delphi study into a research agenda to invite and motivate the community of scholars to collaborate and interlink the various field-specific perspectives with the ultimate aim to holistically map and delineate the field of digital accounting.

This research agenda may help to better understand the digital transformation towards a fully autonomous accounting and may also assist to make this very transformation happen by providing empirical data-based guidance to practitioners as well as policymakers. The outcome of our collective research should also inform society on the broader opportunities and threats stemming from a fully autonomous accounting and help them form an educated opinion on the implied societal changes with its ethical challenges.

The agenda is structured into the following five perspectives as follows in figure 2.

Figure 2 Perspectives on Research in Digital Accounting, source: authors

1. Organisational transformation

Many scholars would agree that any transformation of such gravity in accounting most likely goes together with a substantial organisational transformation. Depending on the chosen theoretical framework however, causations can be assumed in either, or even neither direction between these two. Thus, the interplay between the nucleus of accounting transformation and the immediate organisational context as well as the larger societal context will be one of the important issues from an organisational science perspective.

Insights from empirical studies framed for example in a neo-institutional theoretical setting that accepts the separation of human actors and structure (such as the norms and traditions of the accounting profession) and takes a certain drive for standardisation and isomorphic adaption for granted, will certainly provide valuable starting points. Giddens structuration theory (Englund and Gerdin, 2014) with its notion of transcending the structure-agent separation towards a system of accountability with situated practises (Conrad, 2014), Latour's actor-network theory (ANT) that adds non-humans as actors (Robson and Bottausci, 2018; Latour, 2005) and creates fluid accounting objects that are translated into a system, or configuration theory (and earlier contingency theory) with its focus on the organisational *gestalt* or habitus (Bourdieu and Nice, 1977) being shaped by a complex contextual interplay (Otley and Berry, 1980), may be other worthwhile perspectives to understand and explain the organisational changes we expect to see in the coming years.

What all these theoretical approaches have in common is that they lean towards a pragmatic worldview, which is not limited by the often artificially-conjured dichotomy of a realist versus constructivist ontology in the social sciences and thus allows researchers to embrace a variety of epistemological approaches with a range of suitable research designs. This may also be particularly necessary because the sheer dimensions in terms of size and speed (Crookes and Conway, 2018), and especially the interconnectedness between the levels on which change is about to happen will potentially transcend current literature on change in organisations - while at the same time we expect much of the current theory of change to remain at least partially valid in this new, rapidly changing context. Following Edmondson and McManus (2007), such an intermediate state of theory needs to be approached by mixed-methods designs, combining inductive and deductive reasoning.

2. Individual: workers, managers, shareholders and other stakeholders

A strong focus on the human and societal factor in the transformation towards a fully autonomous accounting seems timely and apt. On the one hand, it is certainly pressing from a practice point of view, as the technological advancements will inevitably have a strong impact on the existing roles, duties and corresponding skills of workers, managers and recipients of reports in the accounting profession (Neely and Cook, 2011), as well as on stakeholders in general.

For the employees in the field, we need to understand the new job-roles and matching qualifications that are necessary in order to not only persist in this new area but also to help deal with the aberrations that any change process will inevitably bring with, with the ultimate goal to further develop the accounting profession. Questions in this area will be about the career-prospects, related skills and how our education systems can deal with the demand, but also about the necessary tools to support human cognition given a highly abstract and aggregated level of information (such as visualisations and interactions); about the psychological factors when it comes to change management and the necessity to adapt, and finally to questions of power and control. In this, Foucauldian perspectives on what constitutes power from a critical discourse perspective may help to identify problematic developments and allow to raise the right questions in society. The meta theories of capabilities or the resource-based view (RBV) may provide other suitable and less critical approaches to understand and

guide the interplay between organisational leadership and the role of humans in an autonomous accounting world. From a strategic management perspective these theories may help us understand how a competitive advantage can be created and maintained given such rapid organisational transformations.

The decisive change for individuals in this can be seen as a FAAS will not only provide the decision-relevant information but already propose the decision itself based on this very information. Following these lines of thought; how to ensure a bias-free cognition, and who ultimately controls the firm and its resources for what purpose will be amongst the most pressing issues in this. Thus, from the perspective of the individuals having to deal with the output and decision making of a fully autonomous accounting system several questions will arise. Such questions will not only include the role of trust into the decisions of such systems but also comprise more collective fears concerning how sustainable a functionalist, AI-based assessment without human values can be.

3. Regulation: Standards and Transparency

From a regulatory side, the need for transparency of the internal processes and internal decision-making criteria of the AI to comply for example to the GDPA criteria is still not sufficiently solved and it may take a while to reach a satisfactory level. In the meantime, accounting and information systems researchers may need to look into which levels of transparency for which applications are really necessary. There will certainly be a difference from a regulatory requirements perspective, internal advisory systems based on AI-derived cost-predictions and external compliance-reports based on true big data when it comes to traceability, confirmability and finally transparency. To solve the problem of transparency and accountability of an FAAS, researchers need to first fully understand how deep learning systems simulate cognition, especially when it comes to multi-functional networks. The learning process based on feed-back loops, which leads for example to the known problems of overfitting and easily introduces a potential sample-bias may provide more hurdles to take before a truly transparent, traceable and accountable autonomous accounting can be possible.

Besides the necessary regulatory changes, for example concerning labour-rights and standards, taxation and data protection, other interesting insights may include the necessity to redefine the role of auditors and authorities to ensure compliance with these changes.

Other worthwhile endeavours may be to define how accounting standards need to adapt to better reflect the quality and worth of the collected data and the derived intelligence of such an FAAS as intangible assets.

Finally, research needs to carefully monitor and guide regulatory communication that is not only comprehendible by humans but can be processed by accounting systems, such as the already existing IFRS or FASB codifications.

4. Innovation

Research in this area needs to look at IT-architectures and infrastructures, and how these technological artefacts in term influence the practice and control of an FAAS. The above described necessity to include external data of various sources and with various formats into a vast, virtual data repository will bring with many questions. What is more, a variable-efficient problem-modelling that is informed by information-theoretical concerns of which data is needed and what may be available in abundance would catapult current solutions towards a much higher practical usability. In this, accounting and information-science scholars would need to work together with data-scientists to identify both, theoretical frameworks as well as corresponding algorithmic solutions.

In this perspective, we identified the most salient questions as:

1. How should the ideal infrastructure be laid out depending on the tasks and context - including considerations on cloud versus internal storage and computing power, speed, scalability and flexibility, but also most importantly concerning availability?
2. How to algorithmically define and enforce data rights and ensure protection and compliance to data-regulations. What may the role of public or private Blockchains be in this?
3. How the FAAS can base its calculations and decisions on just the relevant information and by this use its resources efficiently - for example through clever feature selection and by avoiding overly complex models. In other words, how can the human domain know-how and related heuristics be translated into an FAAS and how can algorithms such as ridge or L2 regressions help avoid overfitting to enhance external validity?
4. How standardization might help but also diminish the (open) data exchange depending on the various sources in various contexts.
5. What is the meaning of Artificial Intelligence in an FAAS and where may be its limits and the potentially ongoing necessity for a human-interaction?
6. Following the previous question, how can the inner workings of a deep learning network as the basis of an FAAS be made transparent and how can the system create targeted communication (including visualisation) of complex data structured on an aggregated level that still allows to validate the outcome by interaction?
7. Related to this, how can an isomorphic bias, based on hindsight learning from the machine-based decisions (leaving out alternatives) be avoided and what security measures need to be in place to control an FAAS.
8. How to ensure a practical decision making when the existing data does not sufficiently specify the problem at hand.

5. Ethical Implications

Finally, but potentially most important, research needs to bring in the different voices from society about how ethical boundaries need to be in place when it comes to fully autonomous decision making of AI powered accounting systems. The role of cultural standards, and potentially the role of the firm itself needs to be revisited. We already see for example in entrepreneurship research with its recent discussions on hybrid business-models, that environmental, social as well as commercial factors need to be taken into account when it comes to strategic decisions. Such factors may be underrepresented in any purely data-based FAAS, as the more unstructured and less-quantifiable non-financial information may be harder to process and much more scarce compared to “hard” and easy to digest financial information. Critical literature on sustainability already questions the rationality behind any ESG (environmental, social and governance) guided decision-making and identifies mostly reputation risks and legitimacy as rational motivations. Reading the current streams of literature in digital accounting it becomes clear that any ethical considerations need to be enforced by rules and regulations and cannot be based any more on the personal, human values of managers. The AI answers to how a data-derived strategy shall be put into place needs to be carefully monitored and a societally accepted way of integrating the people, planet and profit thoughts into the mere functionalist approaches of non-human actors has to be found in a process that includes more than industry and policy-makers.

Any ethical considerations, as far as such considerations are even possible on a meta-level without a cultural context will need to be inserted as rules and the impact of potential sample-bias in machine learning has to be looked at from various, critical angles. However, that’s not to say that such AI data-derived decision making cannot have its merits, as nepotism and other

irrational behaviour of managers would be potentially reduced. Therefore, agency theory may well interplay with philosophical and (critical) sociological approaches to build a solid foundation of what the role of ethics should be in FAAS.

Conclusion

In our understanding and based on the existing literature digital accounting needs to be seen as an interdisciplinary research field. Therefore, based on literature from various disciplines, scholars as well as practitioners from various disciplines are invited to collaborate on future scenarios of a fully autonomous accounting.

Based on the literature review and early empirical insights, we propose an early maturity-level framework and derive a corresponding research agenda. This maturity level framework starts from a digitally assisted accounting focusing on providing support for data preparation, planning and reporting and ends in a fully autonomous accounting system focusing on artificial intelligence as accountant and advisor with advanced cognitive abilities. In order to reach the final stage of a fully autonomous accounting system, an organizational and social change process is necessary in addition to the necessary technological advances.

The research agenda for the field of digital accounting finally comprises five perspectives, namely organisation, individual, regulation, innovation and ethics, and potential theories within each of these perspectives are proposed.

We sincerely hope you enjoy this special issue of the ACRN Oxford Journal of Finance and Risk Perspectives on Digital Accounting, and are looking forward to your replies and comments, and to further research papers on this fascinating topic.

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