Digital Technologies

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Abstract*: Digital technologies have led to tremendous and fast-paced changes in almost all areas of life. Over the last three decades, advances in nanotechnology have enabled hardware development with steadily increasing computational power (Dingli et al., 2021)*

Keywords: Digital technologies

I. INTRODUCTION

Digital technologies have led to tremendous and fast-paced changes in almost all areas of life. Over the last three decades, advances in nanotechnology have enabled hardware development with steadily increasing computational power (Dingli et al., 2021). As a result, digital developments like the Internet of Things or big data analytics are increasingly applied and used in many different areas. One of the most trending and hyped technologies of the digital age is artificial intelligence (AI) (Chollet, 2021). Driven by the aforementioned technological advances, AI has gained considerable attention and interest among managers and academics in recent years (Brock and von Wangenheim, 2019). Today, AI is used for many use cases, including speech or image recognition, medical diagnoses and automatizing routine labour (Goodfellow et al., 2016).

II. FOUNDATIONS

Accounting information systems are mainly rule-based, and data are usually available and well-structured. However, many accounting systems are yet to catch up with current technological developments. Thus, artificial intelligence (AI) in financial accounting is often applied only in pilot projects. Using AI-based forecasts in accounting enables proactive management and detailed analysis. However, thus far, there is little knowledge about which prediction models have already been evaluated for accounting problems. Given this lack of research, our study aims to summarize existing findings on how AI is used for forecasting purposes in financial accounting. Therefore, the authors aim to provide a comprehensive overview and agenda for future researchers to gain more generalizable knowledge.
Design/methodology/approach
The authors identify existing research on AI-based forecasting in financial accounting by conducting a systematic literature review. For this purpose, the authors used Scopus and Web of Science as scientific databases. The data collection resulted in a final sample size of 47 studies. These studies were analyzed regarding their forecasting purpose, sample size, period and applied machine learning algorithms.
Findings
The authors identified three application areas and presented details regarding the accuracy and AI methods used. Our findings show that sociotechnical and generalizable knowledge is still missing. Therefore, the authors also develop an open research agenda that future researchers can address to enable the more frequent and efficient use of AI-based forecasts in financial accounting.
Research limitations/implications
Owing to the rapid development of AI algorithms, our results can only provide an overview of the current state of research.
Therefore, it is likely that new AI algorithms will be applied, which have not yet been covered in existing research. However, interested researchers can use our findings and future research agenda to develop this field further.
Practical implications
Given the high relevance of AI in financial accounting, our results have several implications and potential benefits for practitioners. First, the authors provide an overview of AI algorithms used in different accounting use cases. Based on this overview, companies can evaluate the AI algorithms that are most suitable for their practical needs. Second,

practitioners can use our results as a benchmark of what prediction accuracy is achievable and should strive for. Finally, our study identified several blind spots in the research, such as ensuring employee acceptance of machine learning algorithms in companies. However, companies should consider this to implement AI in financial accounting successfully.

Originality/value

To the best of our knowledge, no study has yet been conducted that provided a comprehensive overview of AI-based forecasting in financial accounting. Given the high potential of AI in accounting, the authors aimed to bridge this research gap. Moreover, our cross-application view provides general insights into the superiority of specific algorithms.

Digital technologies have led to tremendous and fast-paced changes in almost all areas of life. Over the last three decades, advances in nanotechnology have enabled hardware development with steadily increasing computational power (Dingli et al.,

2021). As a result, digital developments like the Internet of Things or big data analytics are increasingly applied and used in many different areas. One of the most trending and hyped technologies of the digital age is artificial intelligence (AI) (Chollet,

2021). Driven by the aforementioned technological advances, AI has gained considerable attention and interest among managers and academics in recent years (Brock and von Wangenheim, 2019). Today, AI is used for many use cases, including speech or image recognition, medical diagnoses and automatizing routine labour (Goodfellow et al., 2016).

Goodfellow, I., Bengio, Y. and Courville, A. (2016), Deep Learning, MIT Press, Cambridge, MA, London.

Given that, it is not surprising that AI is nowadays a multidisciplinary topic, which has implications for many different disciplines and industries.

Even though accounting is a traditional field with a long history, it has been subject to rapid changes in the past years that come along with the digital age (Berikol and Killi, 2021). In contrast to finance, which focuses on capital management, accounting uses transactional and imputed values to provide a true and fair view of companies' assets, finances and income. While management accounting provides information to internal stakeholders, financial accounting provides information to external stakeholders (Penman, 2013). However, as harmonization efforts between the two subcategories have been observed in recent years, financial and management accounting are increasingly converging.

By changing workplaces and workflows, digital technologies lead to new opportunities in the accounting profession, but also demand new skills from the employees (see, for example, Leitner- Hanetseder et al., 2021; Kruskopf et al., 2020; Guthrie and Parker, 2016). Although accounting has always been subject to changes, current developments like the digital transformation and regulatory forces lead to developments that are more rapid and drastic than before (Hajkowicz et al., 2016; Leitner-

Hanetseder et al., 2021). Apart from robotic process automation that already can help with routine tasks in accounting (Cooper et al., 2019; Leitner-Hanetseder et al., 2021), technologies like blockchain (Bonyuet, 2020; Maffei et al., 2021), cloud computing (Huttunen et al., 2019) and big data (Vasarhelyi et al., 2015; Warren et al., 2015) have a major influence on the future of accounting. Among all the digital technologies, AI is said to have a major influence on accounting, as it allows to identify patterns in large amounts of accounting data that can support firms' decision-making as well as be used by stakeholders to conduct financial analyses (Lehner et al., 2022). AI applied for accounting is a topic that has already been frequently discussed in research. Topics that are investigated are, among others, AI's influence on the accounting profession (Stancu and Duțescu, 2021), its current limitations for accounting tasks (Losbichler and Lehner, 2021), or the influence of AI-based accounting on the accountant's profession (Leitner-Hanetseder et al., 2021).

Forecasting in accounting is an application area where AI-based algorithms are often and successfully used (Bertomeu, 2020; Kureljusic and Metz, 2023). The discipline of predicting future business events has a long tradition in accounting and has been investigated for decades. In the 1990s, the first ideas appeared that suggested the use of neural networks, a group of methods of AI, for accounting-related forecasting tasks. For example, neural networks were used to predict quarterly accounting earnings (Callen et al., 1996), financial distress (Coats and Fant, 1991) or bankruptcy (Jo and Han, 1996). Since these pioneering works in the '90s, AI and its use cases for accounting forecasting have seen tremendous research growth. New and more sophisticated AI methods emerged, and computing power, as well as available data

volumes, increased. Likewise, the amount of research that uses AI for forecasting in accounting has grown steadily (Moll and Yigitbasioglu, 2019; Agostino et al., 2022).

AI-based forecasting for financial accounting tasks is a topic that is often and increasingly investigated. Despite the growing interest, the research within this field is dominated by the computer science or management discipline. These previous research projects mostly take a technical point of view and investigate specific AI algorithms and their accuracy for selected data sets, which often exclude outliers to achieve more accurate results. We believe that future researchers could make a wide variety of valuable contributions to research about AI-based forecasting within accounting. AI-related topics that so far are not investigated in accounting are, for example, user interactions with AI systems (Rzepka and Berger, 2018), the integration of AI with organizational strategies (Borges et al., 2021), or explainable AI (Meske et al., 2020).

Right now, to the best of our knowledge, there is no comprehensive review about AI-based forecasting in financial accounting that could serve as an initial understanding of this topic for future researchers. This lack of research is surprising, given the increasing relevance of AI for forecasting and the valuable contributions AI could provide. By conducting a systematic literature review, we aim to give a current overview of the research field of AI-based forecasting in financial accounting. This overview involves an investigation of the potentials, existing approaches and different use cases. From this goal, we derive our first research question:

RQ1.

Which AI-based technologies and approaches are used for forecasting tasks in financial accounting, and what are the resulting benefits?

By integrating the findings and results from a broad range of various studies, a literature review helps to advance a research field (Snyder, 2019; Webster and Watson, 2002). We follow the argumentation of Paul and Criado (2020) and believe that a review article should "identify key research gaps" and serve as a platform for further research. We take a holistic perspective to outline what a future research agenda for underexplored topics might look like. Therefore, our second research question is as follows:

RQ2.

How can future studies contribute to the field of AI-based forecasting in financial accounting, and what are promising future research questions and potential use cases?

The remainder of this article is structured as follows. In Section 2, we describe the foundations of financial accounting and AI. These foundations aim to equip the reader with the knowledge necessary to follow this article's further results. After that, in Section 3, we explain the research method applied. Section

4 shows the results of our literature review. Section 5 will present a future research agenda derived from our findings in Section

4. Finally, Section 6 contains a discussion and concluding remarks.

Foundations

Financial accounting

International accounting systems, such as International Financial Reporting Standards (IFRS) and United States Generally Accepted Accounting Principles (US GAAP), aim to present the actual net assets, financial position and results of a company's operations. This information is included in the financial statements, primarily intended to provide potential and existing investors with information useful for decision-making (Penman, 2013). The characteristic feature of accounting systems is their rule-based bookkeeping. Assets and liabilities are mostly recognized according to clearly defined criteria (Dai and Vasarhelyi, 2017). In this context, double-entry bookkeeping plays an elementary role in recording business transactions. Each business transaction is recorded both on the account and the offsetting account. The entry records are always balanced since each debit has a corresponding credit entry. The advantage of double-entry accounting over single-entry accounting is that transactions can be better tracked and verified (Sangster, 2016). This makes it easier for third parties, such as auditors and investors, to understand the business transactions. However, double-entry accounting also has its limits. Ensuring the accounting equation of credits and debits does not guarantee that the correct accounts have been considered for accounting (Dai and Vasarhelyi, 2017). In addition, there is still a risk of fraudulent activities, as bookings can be modified

Research method

In this article, we aim to find an answer to the question of how AI-based algorithms are used for forecasting within accounting-related tasks. A literature review helps classify and integrate relevant findings from multiple disciplines by systematically collecting research. Therefore, we consider a systematic literature review as a useful method for generating a comprehensive overview of this research field that can serve as an initial overview and foundation for further studies. In conducting our systematic literature review, we follow the processes proposed by Kitchenham and Charters (2007) and Snyder (2019).

Although many different databases of scientific publications exist, we chose the Scopus and Web of Science (WoS), since these are among the largest ones (Forliano et al., 2021). The WoS contains scientific publications from 3,300 publishers and more than 12,000 journals (Mustak et al., 2021) and covers around 90 million documents (Forliano et al., 2021). Additionally, we used Scopus as a second database to cover a wider range of publications and minimize the risk of missing relevant literature. First, Scopus contains even more journals than the WoS (Paul and Criado, 2020). Furthermore, it has the advantage of not only covering journals or conference proceedings but also trade publications, books and different web sources (Kulkarni et al., 2009).

After the database selection, we constructed a search string. First, the search string needs to cover the technical part of AI-based technologies. Apart from artificial intelligence, we included machine learning and deep learning since these terms refer to two of the most popular AI-based methods. Furthermore, we included supervised, unsupervised and reinforcement learning as additional AI- related terms. The search string's second part covers the use-case-related terms. In this study, we wanted to investigate how AI is used for forecasting in financial accounting. Therefore, we added forecasting, forecast, prediction and predicting to our search string. Since AI-based forecasting is used for many different tasks and goals, we considered it necessary to narrow our search down to accounting. Therefore, accounting was added at the end of the search string. This resulted in the following search string, which we applied in the databases mentioned above: ("artificial intelligence" OR "machine learning" OR "deep learning" OR "supervised learning" OR "unsupervised learning" OR "reinforcement learning") AND (("forecast" OR "forecasting" OR "prediction" OR "predicting") AND "accounting")

The search was conducted on 2 March 2022. We did not specify the time range and aimed to cover the eldest and newest publications. We searched the title, the abstract and the publication's keywords. After eliminating duplicates, the initial sample consisted of 735 unique articles. Our first step was to exclude non-English articles. This led to the elimination of 12 publications. Since we wanted to focus only on peer-reviewed articles, our second step was to exclude non-peer-reviewed articles. This led to eliminating 58 further articles, with 665 publications remaining. Now, we started excluding articles based on the content. To be included for further investigation, the article had to deal with AI-based forecasts for financial accounting purposes. We started to investigate the article's titles. Five hundred and six papers that did not fit our scope according to their title were eliminated, leaving 159 articles remaining. Of these articles, we then studied the keywords and abstracts. This led to the further elimination of 96 publications, remaining 63 publications.

Our last exclusion step consisted of investigating the article's full texts. Here, 16 further articles were considered to not fit our sample. As a final step, we completed our literature collection by applying backward searches to the remaining 47 articles. However, we could not find additional studies that were not already identified. This led to a final sample of 47 articles that were investigated. Figure 1 summarizes our applied literature collection steps.

CONCLUSION

In recent years, AI has made it possible to search for patterns of increasing complexity. The patterns identified can be used for predicting companies' developments.

Especially in accounting, it can be observed that prediction studies increasingly contain larger sample sizes over time and that the models produce more accurate forecasts. In this paper, we investigated the current research status in the field of AI-based predictions in financial accounting and provided the first systematic literature review in this emerging field of research. Our first research goal was to present an overview of how AI- based technologies and approaches are used for forecasting tasks in financial accounting. Furthermore, we aimed to outline a future research agenda from a holistic perspective. To answer these research questions, we conducted a systematic literature review of several scientific databases to identify relevant research and publications.

Our findings indicate that, so far, there are three main application fields for AI-based forecasts in financial accounting. The areas of application range from bankruptcy forecasts to financial analysis as well as fraud and error detection. Especially existing and future investors can benefit from these predictions, as knowledge about future business developments helps to avoid bad investments. Previous studies show that support vector machines, neural networks, and random forests provide accurate and robust predictions for all three application areas.

However, there is little evidence of whether one prediction model provides significantly more accurate forecasts than others. Especially for financial analysis, it is difficult to derive generalizable knowledge, as different financial variables are predicted (e.g. revenues, cash flow and earnings). Future research needs to evaluate the predictive performance of models on different data sets with common properties to address this research question.

Furthermore, most studies do not consider issues related to the implementation and maintenance of forecasting models. Thus, the human role in the forecasting process is mostly neglected by prior research. Future research can make a significant contribution to closing these research gaps and more closely link computational science and accounting research. By using DSR, IS artefacts can be developed and evaluated besides IT artefacts, holistically addressing the implementation of prediction models in organizations.

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