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Structural Equation Modelling in accounting research: A review of prior studies and further research opportunities

Modelowanie równań strukturalnych w badaniach z zakresu rachunkowości: przegląd dotychczasowych prac i możliwości dalszych badań

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Abstract

Purpose: The main aim of this paper is to present and discuss the application of Structural Equation Modelling (SEM) in accounting research. Following an overview of the terminology, statistical concepts, and software used in SEM, the results of a systematic review of the accounting literature are presented, with a focus on the benefits and challenges identified in prior studies.
Methodology/approach: This paper is based on a traditional literature review, which helps to demonstrate SEM as a research technique. It is also based on a systematic literature review, which is used to present previous applications of SEM in accounting studies.
Findings: SEM offers the possibility to model statistically complex theoretical issues using specialised software. It is a flexible and universal approach used by quantitative accounting scholars to test and develop theories. SEM research is heterogeneous and encompasses different research strategies, theories tested, branches of accounting, data collection methods, and types of statistical analyses.
Research limitations/implications: The main limitation of this study is that the complexity of SEM statistical analyses cannot be discussed in detail within the scope of this paper.
Originality/value: SEM is gaining popularity among accounting scholars; however, it is not widely used by Polish researchers. Therefore, this paper is a kind of invitation to quantitative scholars to examine SEM and its potential. It is also a contribution to the current discussions on the automation of research processes.
Keywords: accounting research, quantitative methods, structural equation modelling, systematic literature review, automation of research processes.

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Streszczenie

Cel: Głównym celem artykułu jest przedstawienie i przedyskutowanie zastosowania modelowania równań strukturalnych (*Structural Equation Modelling* – SEM) w badaniach z rachunkowości. Omówiono syntetycznie terminologię, koncepcje statystyczne i oprogramowanie wspomagające SEM, przedstawiono wyniki systematycznego przeglądu literatury z rachunkowości, koncentrując uwagę na korzyściach i wyzwaniach zidentyfikowanych we wcześniejszych badaniach.
Metodyka/podejście badawcze: Praca jest oparta na przeglądzie literatury. Tradycyjny przegląd literatury pozwolił zademonstrować SEM jako technikę badawczą, systematyczny przegląd literatury służył do przedstawienia wcześniejszych zastosowań SEM w badaniach z rachunkowości.
Wyniki: SEM daje możliwość modelowania statystycznie złożonych problemów teoretycznych przy wsparciu specjalistycznego oprogramowania. Jest to elastyczne i uniwersalne podejście stosowane przez badaczy ilościowych z zakresu rachunkowości do testowania i rozwijania teorii. Heterogeniczność badań SEM dotyczy strategii badawczych, testowanych teorii, obszarów rachunkowości, metod zbierania danych, czy rodzajów analiz statystycznych.
Ograniczenia/implikacje badawcze: Główne ograniczenie tej pracy związane jest ze złożonością analiz statystycznych SEM, które trudno zaprezentować w jednym artykule.
Oryginalność/wartość: SEM zyskuje popularność wśród badaczy z rachunkowości, jednak nie jest szeroko stosowany przez polskich badaczy. Artykuł jest swego rodzaju zaproszeniem dla badaczy ilościowych do zwrócenia uwagi na SEM i jego potencjał. Stanowi także przyczynek do toczących się dyskusji na temat automatyzacji procesów badawczych.
Słowa kluczowe: badania rachunkowości, badania ilościowe, modelowanie równań strukturalnych, systematyczny przegląd literatury, automatyzacja procesów badawczych.

Introduction

Accounting research has a long tradition of testing and developing hypotheses through quantitative studies. Numerous accounting studies are built not only on archival data from reports and other accounting disclosures but also on primary empirical data obtained through surveys or experiments that depict perceptions, attitudes, behaviours, or intentions. Moreover, accounting scholars are becoming more aware of and interested in grasping the complexity of the phenomenathey are studying through elaborate models with numerous constructs, relations, or sequences. The prevalence of this approach may explain the recognition of structural equation modelling (SEM) in accounting research (Lee et al., 2011; Nitzl, 2016). As most literature on SEM underlines (Kaplan, 2008; Kline, 2011; Hair et al., 2013; Civelek, 2018; Westland, 2015), the most important characteristics and primary benefits of using SEM are the possibility to test complex models and, crucially, to test measures and relations in the model simultaneously. What is also important is that the current use of SEM-based research is supported by specialised software that enables researchers to test complex models and analyse their goodness of fit, etc., even with a modest knowledge of statistical methods.

Previous literature reviews (Lee et al., 2011; Nitzl, 2016) demonstrated the growing popularity of SEM applications in accounting research, the benefits of SEM, and knowledge of the disadvantages and hazards of using it improperly. The review of Polish accounting journals, in contrast, reveals much less familiarity with and understanding of SEM applications. For instance, "Zeszyty Teoretyczne Rachunkowości" ("The Theoretical Journal of Accounting") recently published only one paper with SEM as a keyword, i.e., the work of Meier and Esmatyar (2016) on behavioural finance. The study was based on a large sample of companies listed in Germany, and it discussed evidence of the influence of managerial optimism on companies' financing policies and cost of capital. This could be further evidence of the need to present SEM to Polish researchers in order to introduce it as a research technique, analyse its applications, and identify its potential benefits and threats. Accordingly, the primary purpose of this paper is to delineate the idea of SEM with a brief introduction to the statistics behind this technique. It will also delineate the current state of existing research and the implications for further inquiries in accounting.

The contemporary development of SEM makes it nearly impossible to present it in detail or make it comprehensible to novices. However, apprehension of the main concept can be an adequate source of inspiration and form the foundation for further studies. The general aim of this work, therefore, is to promote SEM usage by helping to eliminate potential barriers that might prevent accounting researchers from using this approach in their quantitative studies.

The main research method used in this paper is a systematic literature review (SLR)[1] guided by two specific research questions: (1) What are the main bibliometric characteristics of the accounting literature on SEM-based research?; and (2) What are the main advantages and challenges pointed out by the authors of the selected publications regarding the use of SEM in accounting studies?

The structure of the paper is as follows: First, a concise overview of SEM is presented, including the terminology used in model construction, major statistical concepts behind SEM, and software that researchers commonly use. Next, the results of the systematic literature review (SLR) are discussed. The review was oriented towards delineating the scope of SEM-based accounting research, the journals that publish this kind of research, the major topics addressed, and the theories tested or developed in these studies. Finally, in the discussion section, some recommendations, as well as more general reflections about the future of

[1] A traditional (narrative) literature review provides a general overview of a research topic with no clear methodological approach. Information is gathered and analysed unsystematically with subjective summaries of the findings. A systematic literature review is usually undertaken to clarify the current state of existing research and the implications that should be drawn from it. An SLR can demonstrate the present state of research on a subject, identifying gaps, main areas of research, links among them, or areas that require further research. SLR studies are based on a protocol that documents the information gathered and the steps taken in order to make the selection process transparent and reproducible. For more details, see Jesson et al. (2011).

SEM-based research in accounting, are provided. The advancement of automation, or "e-science" in particular, is viewed as a factor that influences the potential further spread of SEM-based research in accounting studies.

1. Outline of SEM: Concept and terminology

Essentially, SEM is a popular method (or range of methods) of analysis that allows for the examination of various models that explain data structures and relationships. SEM is a label for a group of analytical techniques used both for observational and experimental research, for confirmatory and exploratory purposes, as well as for cross-sectional and longitudinal data. Its primary purpose is to determine the extent to which a proposed theoretical model, often expressed as a set of relationships among different constructs, is supported by the collected data (Lewis-Beck, 2004; Jodie, Ullman, 2006; Bagozzi, Yi, 2012; Civelek, 2018). In consequence, SEM is utilised to examine complex models in which one or more independent variable(s) can relate to one or more dependent variable(s). Owing to its flexibility and universality, this research approach has grown immensely popular across various disciplines (Nitzl, 2016; Dash, Paul, 2021), and it seems to be particularly useful in social science, where many, if not most, key concepts are not directly observable (Westland, 2015).

SEM always employs *statistical models* (and software) to investigate the structural connections between latent variables that underlie the actual or observed variables, i.e., taken from observed data (Kline, 2011). What is important, however, is that SEM must be sustained by *theory* in order to develop or modify the proposed and tested model (Shook et al., 2004; Williams et al., 2009). It is considered a response to two major requirements of quantitative research: the need to describe the operational measures of the conceptual variables by means of the theory under examination and the use of these measures to examine the relationships between the conceptual variables as hypothesised by the theory.

In general terms, SEM evaluates two models: *the measurement model*, which measures how well-hidden (latent) variables are represented by the observed variables, and *path analysis*, which depicts the relationships among the latent variables. Thus, from a statistical standpoint, SEM simultaneously combines factor analysis and linear regression models for theory testing (Williams et al., 2009; Tarka, 2018). On the one hand, the measurement model originates from a much broader category of factor analysis, while the other major constituent, path analysis, allows a researcher to represent complex relationships among various variables and visually represent them in a path diagram. Therefore, during the research process, a researcher might use exploratory factor analysis to develop evidence that the measures properly reflect the underlying constructs, and they might subsequently use linear or logistic regression to identify significant predictors as proposed by the theory. The combination of these two components makes this approach highly convenient and beneficial. This might explain why,

since the early 1980s, a growing number of social researchers have been using SEM as a research method (Williams et al., 2009; Hair et al., 2013; Tarka, 2018; Westland, 2018).

SEM may be used as a more powerful alternative to multiple regression analysis, path analysis, factor analysis, time series analysis, and analysis of covariance, and these procedures may even be considered special cases of SEM. In particular, the SEM toolkit includes confirmatory factor analysis, confirmatory composite analysis, path analysis, multigroup modelling, longitudinal modelling, partial least-squares path modelling, latent growth modelling, and hierarchical or multilevel modelling (Bagozzi, Yi, 2012; Kline, 2011; Kaplan, 2008).

There are several elements in the traditional notation and terminology of SEM. Structural equation *modelling* involves creating a model that represents how various aspects of a particular phenomenon *are thought to causally connect* to one another. SEM contains postulated causal connections among some *latent variables*, i.e., variables thought to exist but which cannot be directly observed. Additional causal connections link those latent variables to *observed variables* whose values appear in a dataset. Latent variables (*factors*) are the unobserved constructs that represent the concepts of a theory, e.g., accountants' participation in strategic decision-making (Cadez, Guilding, 2008), sustainable market orientation (Bastini et al., 2022), or dedication to the profession (Shafer et al., 2002). They are measured by their respective *indicators*, i.e., observed variables – occasionally called manifest variables or reference variables – such as items in a survey instrument, e.g., responses to "I would stay in management accounting even if I had to take a slight pay cut" provided on a five-point Likert scale that measures the respondent's attitude (Shafer et al., 2002). Observed variables in SEM can be categorical, discrete, or continuous (Civelek, 2018). The data from measures (indicators) are used as input for statistical analyses that provide evidence of the relationships among latent variables (Williams et al., 2009), which include independent, mediating, and dependent variables.

As previously noted, the relationships between the latent variables and their indicators are collectively referred to as a measurement model that represents an assumed process where an underlying construct determines or causes behaviour (e.g., a response to a survey question) as reflected in measured indicator variables. In SEM, both *formative* and *reflective measurements* are used (Coltman et al., 2008; Williams et al., 2009; Hair, 2013). In reflective models, the indicators are affected by the latent variable, e.g., an accountant's personal commitment is believed to cause specific measured indicators, such as the willingness to stay in management accounting even with a slight pay cut. In contrast, in formative models, the indicators define the latent variable. For instance, the measurement of company performance may comprise various components, such as ROI, market share, or earnings per share, as separate elements of a formative measurement (Nitzl, 2016). Next, the researcher can choose to use individual questionnaire items as indicators (referred to as total disaggregation), or, instead, they can combine items from each scale into subsets called parcels and use these as indicators of

the latent variable (referred to as partial disaggregation) (Williams et al., 2009). Crucially, each indicator is also potentially influenced by a second independent variable in the form of a measurement error that contributes to its unique variance, which comprises two parts: systematic variance and random error variance (Bagozzi, Yi, 2012).

In its second component, SEM depicts relationships among the latent variables. This part of the overall model is referred to as the structural model. The model includes a correlation between the *exogenous* latent variables (independent latent variables), regression-like structural parameters that link the exogenous latent variables with *endogenous* (dependent) latent variables, and a similar regression-like structural parameter that links the endogenous latent variables. Finally, the model also acknowledges that there is unexplained residual variance in the endogenous latent variables (Williams et al., 2009).

To evaluate the structural equation model, a researcher starts with a covariance matrix from a given dataset among the measures used as indicators. The most common parameter estimation procedure here is maximum likelihood,[2] and, presently, a researcher would rather use specific software that provides support for the calculations.[3] Respectively, the analysis of the model and its fit are conducted. There are various measures of model fit (e.g., the chi-squared statistic or the goodness-of-fit index GFI) that reflect the adequacy of the model and which ultimately reflect the similarity between the sample covariance matrix and a predicted covariance matrix.[4] The researcher might also compare the model with an alternative model using the same data – for instance, an alternative model that includes additional direct paths from the two exogenous variables – and subsequently compare the two models using a chi-squared difference test.

SEM is usually viewed as a confirmatory rather than an exploratory procedure, as it uses goodness-of-fit tests to determine if the pattern of variances and covariances in the data is consistent with a structural (path) model specified by the researcher. However, as the researcher may test two or more causal models to

[2] Parameter estimation is done by comparing the actual covariance matrices that represent the relationships between variables and the estimated covariance matrices of the best fitting model. This is obtained through expectation-maximisation of a fit criterion as provided by maximum likelihood estimation, quasi-maximum likelihood estimation, weighted least squares, or asymptotically distribution-free methods (Tarka, 2018).

[3] Narayanan (2012) reviews eight different software packages for SEM: Amos, SAS PROC CALIS, R packages SEM, lavaan, OpenMx, LISREL, EQS, and Mplus.

[4] Goodness-of-fit tests determine if the model being tested should be accepted or rejected. The following are among the various tests that can be distinguished: (1) goodness-of-fit tests based on predicted vs. observed covariance (chi-square, GFI, RMSR, SRMR); (2) goodness-of-fit tests that compare the given model with an alternative model (e.g., CFI, NFI, NNFI, RFI); (3) goodness-of-fit tests based on predicted vs. observed covariance but penalising for lack of parsimony (PRATIO, RMSEA); and (4) goodness-of-fit measures based on information theory (AIC). Details of tests and indexes are provided in Civelek (2018) and Dash and Paul (2021), for instance.

select the best fit, SEM combines confirmatory and exploratory purposes: a model is tested using SEM procedures and found to be deficient. An alternative model is subsequently tested based on changes suggested by SEM modification indexes.

Presently, researchers using SEM can choose between CB-SEM (covariance-based) and a variance approach known as PLS-SEM (partial least squares) (Dash, Paul, 2021). Each approach has different assumptions and goals: the premise of CB-SEM is to reproduce the theoretical covariance matrix without focusing on the explained variance, while PLS-SEM aims to maximise the explained variance of the constructs. Moreover, PLS-SEM has less restrictive assumptions than CB-SEM. The philosophical distinction between CB-SEM and PLS-SEM is direct, i.e., if the research objective is theory testing and confirmation, then the appropriate method is CB-SEM. In contrast, if the research objective is prediction and theory development, then the appropriate method is PLS-SEM, which is conceptually and practically more similar to using multiple regression analysis (Dash, Paul, 2021; Hair Jr et al., 2017).

The statistical component of SEM is relatively advanced and constantly evolving. The advances in SEM include confirmatory tetrad analysis (CTA-PLS) to empirically assess the measurement model type, importance-performance matrix analysis (IPMA) of PLS-SEM results, approaches to assessing hierarchical component models, PLS-SEM-specific data segmentation techniques, analysis of interaction effects, and other nonlinear effect or multigroup analysis procedures (Hair et al., 2013). More details on the basics of SEM and the terminology and statistical analyses used can be found in numerous introductory texts, such as Kline (2005), Kaplan (2008), Westland (2015), and Civelek (2018). The advances and recent developments of SEM are discussed in "Structural Equation Modelling: A Multidisciplinary Journal", which is a journal devoted to SEM (published by Taylor & Francis Group).

As numerous prior studies demonstrate (Shook et al., 2004; Nitzl, 2016; Westland, 2015), interest in the application of SEM is growing. Although it is statistically advanced, the practical implementation of SEM appears to be manageable, mostly due to the development of statistical software. Various software packages allow researchers to obtain results without having to understand highly sophisticated statistical methods. First, SEM can examine multiple relationships within the model concurrently, i.e., the causal procedures are represented by a series of structural equations. Second, SEM offers advantages related to statistical complexity: all of the required measurements and tests occur simultaneously in one statistical estimation procedure, where the errors throughout the model are calculated using all modelled information (Lee et al., 2011).

The advantages of SEM compared to multiple regression include, for instance, more flexible assumptions (particularly allowing interpretation even in the face of multicollinearity), the attractive graphical modelling interface, and the ability to handle difficult data, e.g., time series with auto-correlated errors or non-normal data (Hair et al., 2013). Although SEM is frequently used in survey-based research (Lee et al., 2011), it is not methodologically tied to surveys, and it has been

used with data collected through other methods, such as experiments and archival data (Ittner, Larcker, 1997). SEM is used as a universal tool to study both experimental and nonexperimental data, and it can be used for both cross-sectional and longitudinal data. Due to the access to large data samples, the applications of PLS-SEM are currently also expanding towards the estimation of complex models in the context of Big Data and prediction-oriented analysis (Akter et al., 2017). Owing to its flexibility and generality, this method has become hugely popular across various disciplines, including accounting (Dash, Paul, 2021).

However, criticisms of SEM methods include the tendency to accept models without establishing external validity and potential philosophical bias, particularly in presuming cause-and-effect assumptions about complex social phenomena (Hair et al., 2013). However, it must be remembered that the validity of the latent variables (or constructs) should be examined from both statistical[5] and conceptual perspectives.

2. SEM in accounting research: A review of prior studies

This section provides an overview of the current state of SEM application in accounting research and offers inspiration for future research. As discussed above, SEM is a universal and flexible method that is used in quantitative research in various branches of social science. Accounting researchers have ostensibly also noticed the benefits of this complex approach; for instance, Lee et al. (2011) presented a review of 20 papers published between 1997 and 2010 based on PLS-SEM, while Nitzl (2016) analysed the content of 37 papers by means of PLS-SEM and focused on management accounting issues. To depict the current portrayal of the extent and dynamics of SEM-based research in accounting, a broader SLR was conducted in this study.

2.1. The SLR process

An SLR should be guided by a specific research question (or questions) that define its focus (Jesson et al., 2011). Thus, the analytical efforts in this part of the paper were informed by two research questions: (1) What are the main bibliometric characteristics of the accounting literature on SEM-based research?; and (2) What are the main advantages and challenges pointed out by the authors of the selected publications regarding the use of SEM in accounting studies?

[5] It has to be underlined, that there are vague assumptions as to the required sample size (Kline, 2011; Mueller, 1997; Staniec, 2018). E.g., according to Staniec (2018) it can be assumed that 30 observations are required for the PLS-SEM model and 200 observations for the CB-SEM model.

The first phase of the SLR process used for this research encompassed a search in the main bibliographic databases that contain most accounting and auditing journals in order to identify papers presenting the results of quantitative studies conducted with SEM techniques. The SLR investigation started with Scopus and Web of Science, which are robust platforms that provide access to a vast array of scholarly articles and publications. However, the search was broadened to include the Emerald Insight, EBSCOhost, and ProQuest databases in order to not overlook significant academic papers. The advanced search features were used to tailor the examination: search keywords (*account*,* *audit*,* or *structural equation* in the title, keywords, and abstracts), Boolean operators, truncation, and filters (document types, languages, research areas) were applied. Next, the titles and abstracts of the search results were evaluated to identify potentially relevant articles.

The results of such a broad search resulted in a large number of duplicates; thus, in order to resolve the issue of redundant copies, Endnote software was used to automatically remove duplicates in the search results, thereby reducing the number of eligible and unique records to 374 papers published in 60 distinguished journals.

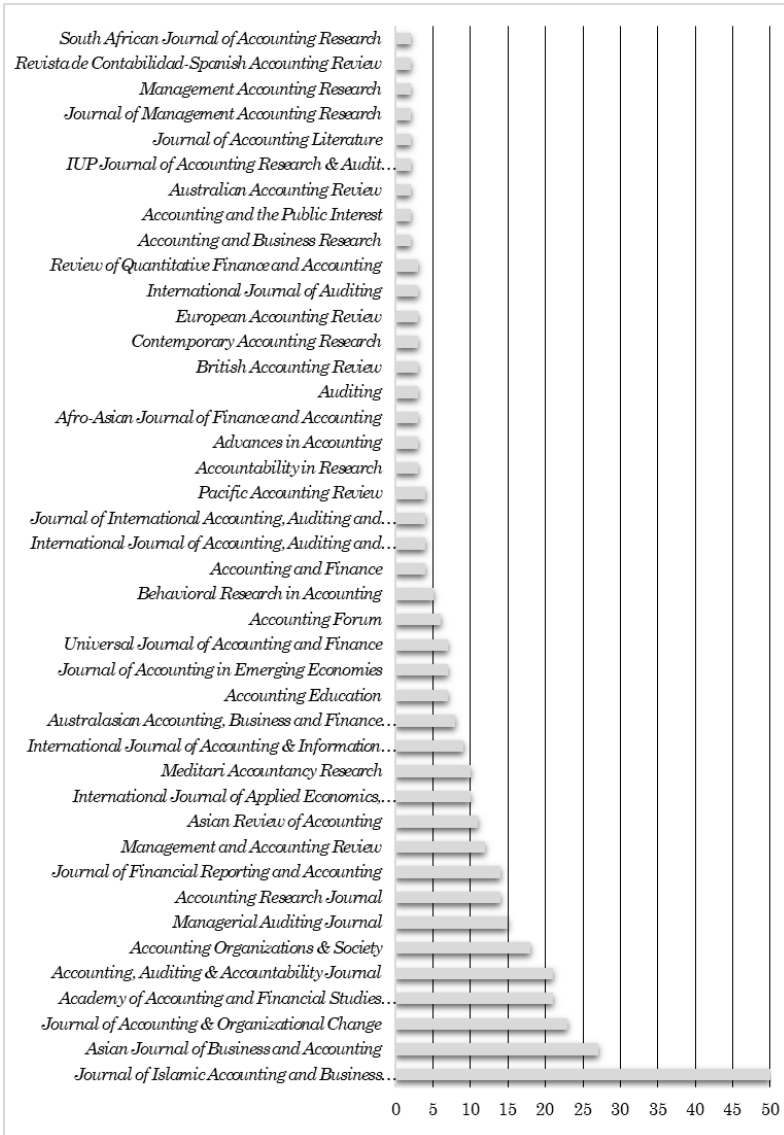
Subsequently, the complete texts of the chosen articles underwent screening in order to extract pertinent data, including article subjects, primary keywords, theories tested or established, and the evaluation of SEM benefits and obstacles provided by the authors of papers chosen throughout the search process.

2.2. Overview of SLR results

The quantitative results of automated bibliographic searches are introduced in Figure 1, demonstrating the scope of SEM-based publications in various journals. However, to make this figure more comprehensible, it was decided to exclude the journals where only one paper was identified; consequently, 42 journals out of 60 were represented.

The results of the literature review illustrate the extended use of SEM in accounting journals such as the "Journal of Islamic Accounting and Business and the Asian Journal of Business and Accounting", i.e., journals that are published in English but oriented towards non-native English speakers. This can be interpreted as further potential for SEM, as it is more readily used by researchers who are not native English speakers because the description of the research and results obtained are more standardised and software-supported. However, SEM studies are also frequently published in "Accounting Organizations & Society" and the "Accounting, Auditing & Accountability Journal", i.e., accounting journals that are highly ranked in Poland and in many other countries around the world.

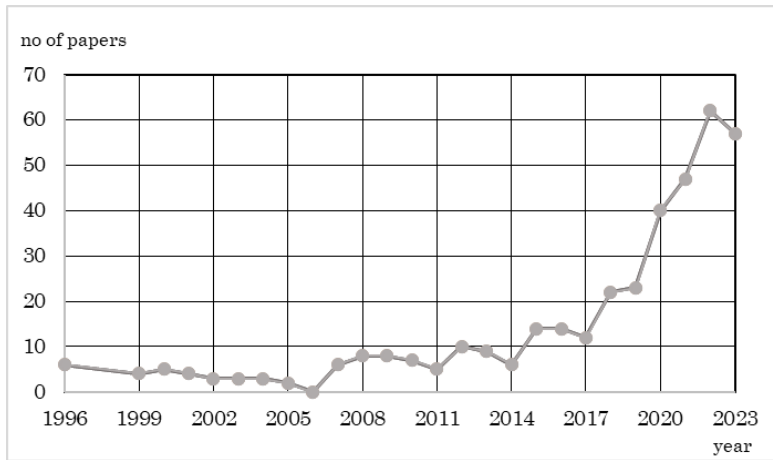
Figure 1. SLR results – main accounting journals publishing SEM-based research



Source: author's own elaboration.

In the next step of the analysis, the dynamics of the published research were examined. It is apparent that the number of papers published annually is increasing (Figure 2), which indicates that accounting scholars have widely adopted SEM, particularly during the past decade. However, this figure only has an illustrative meaning: this growth is largely affected by the multiplication of journals and papers collected by the bibliographic databases.

Figure 2. SLR results – the number of accounting papers with SEM as a keyword



Source: author's own elaboration.

The next issue under exploration has a more qualitative meaning: the content of the selected papers, i.e., the scope of the problems or research questions examined. Noticeably, even the indicative analysis of topics (titles) demonstrated a large variety of research interests; however, for a deeper understanding, a more robust analysis was performed of the various issues covered based on keywords, abstracts, and theories.

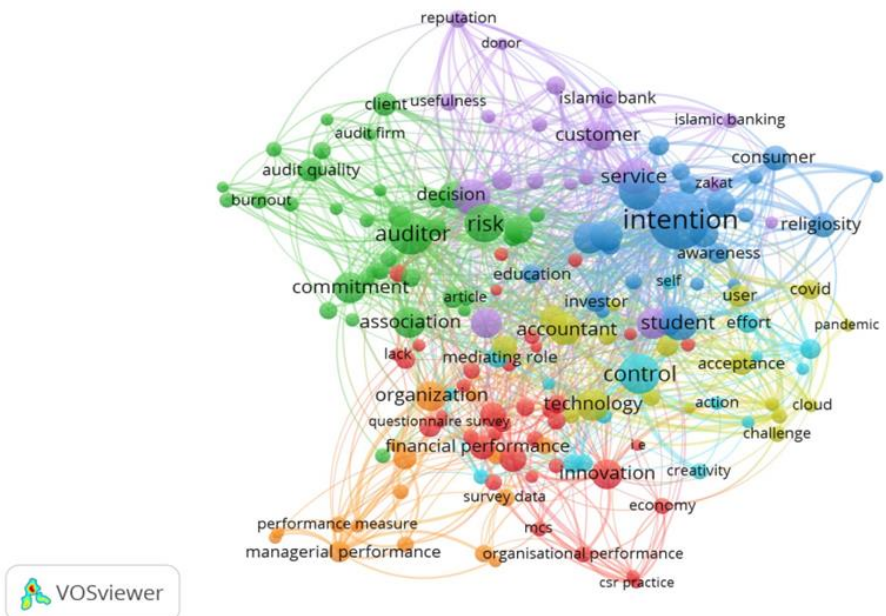
Figure 3. Word cloud of keywords

Source: author's own elaboration.

First, the various issues researched were illustrated by the word cloud generated with the papers' keywords using the MAXQDA software (Figure 3). The importance of general terms such as *performance*, *accounting*, *management*, *financial*, *system*, *audit*, *quality*, and *theory* is noticeable. Next, the terms related to organisational (innovation, strategy, and resources) or behavioural research (ethics, responsibility, attitudes, commitment, personality, and conflict) are apparent among the major keywords in the collection of papers selected.

Similar conclusions can be extracted from the abstract analysis. This part of the investigation was performed with VOSviewer software, which identified the clusters of problems researched (Figure 4).

Figure 4. Thematic clusters identified in the research based on abstract analysis



Source: author's own elaboration.

Figure 4 shows that the VOSviewer algorithm distinguished seven clusters. The following colours distinguish the main clusters: violet – issues related to customers and service; green – auditors and risk; orange – performance; red – innovation; yellow – accountants; blue – intentions. This section of the study again confirms the diversity of the topics in the papers selected for the SLR.

Finally, the analysis explored the scope of the theories tested and developed within the collection of selected papers. The vast list of theories includes the following: goal setting and social exchange theory (Groen, 2018), flow theory (Maryam et al., 2021), contingency theory (Ghasemi et al., 2019; Namazi, Rezaei, 2023; Uyar,

Kuzey, 2016), social exchange theory (Taha, 2023; DhaifAllah et al., 2020), the theory of planned behaviour (Sarikhani, Ebrahimi, 2022; Tan et al., 2023), stakeholder theory (Deb et al., 2023; Mir, Rezania, 2022), institutional theory (Deb et al., 2023), unified theory of acceptance and use of technology (Al-Okaily et al., 2023; Ferri et al., 2021), the theory of reasoned actions (Polyorat, Buaprommee, 2016), motivation crowding theory (Van der Kolk et al., 2019), and self-determination theory (Rahi, Abd. Ghani, 2019). This register again confirms the diversity of accounting research conducted using SEM techniques.

2.3. The evaluation of the SEM method by the authors of the SLR-selected papers

This section summarises the selected studies identified in the SLR, addressing the second research question: What are the main advantages and challenges pointed out by the authors of the selected publications regarding the use of SEM in accounting studies?

Following the best practices of academic research, the authors quite frequently mention their motivation for choosing SEM, as well as the limitations of the results. The structure of the papers demonstrates an outward similarity. Commonly, after presenting the theoretical frameworks and literature reviews that justify the hypotheses, the authors focus on the research process, providing details of sampling and measurement approaches, indicating the type of SEM and the kind of software used for statistical analyses, and, finally, discussing the results of hypotheses testing and indicating the contributions of the relevant theory.

In the authors' comments on the evaluation of SEM as a tool for their explorations, they seldom underline the benefits of this approach. Presumably, they take for granted the possibility of statistically modelling complex theoretical issues with specialised software, of which the advantages are commonly known and broadly accepted. Johansson, Siverbo, and Camén (2016) point out that SEM makes it possible to handle latent variables in a rigorous way that builds on a theory or model testing assumption rather than mere exploration. Bastini, Getzin, and Lachmann (2021) underline that SEM (PLS-SEM in particular) is a useful method for complex models with numerous constructs and various dependent and independent variables, even in combination with small samples. In other cases, where the reasons behind the choice of SEM use are explained, the authors state that it is particularly appropriate for modelling relationships between constructs where the theory is relatively established and a considerable body of knowledge exists (Cadez, Guilding, 2008). In consequence, SEM is a superior approach for researchers who aim to develop a well-established theory.

However, the authors also frequently discuss the limitations of the method. SEM is denoted as a source of important considerations regarding results that should be interpreted with a measure of caution. The first and likely most important consideration relates to the relationships in the model that are all based on correlational data and thus do not establish causal relationships among the

variables (Chong, Johnson 2007; Shafer et al., 2016). Owing to this, terms such as *antecedents* and *consequences* are used in the discussions of many studies (Chong, Johnson, 2007; Abdel-Maksoud et al., 2021). However, various statements about the relationships proposed can be made in terms of their consistency with the relations and their directions proposed in the theoretical sections of the papers.

The second limitation relates to the complexity of the issues researched. Even when constructing and testing highly complex models, some authors demonstrate their awareness of other potential independent, mediation, or control variables that are omitted in the path model (Chong, Johnson, 2007; Abdel-Maksoud et al., 2021; Thoradeniya et al., 2015). In terms of the number of contingency factors, highly complex models are, nevertheless, incomplete, as there are doubtless other significant contingency factors that the researchers have not captured (Cadez, Guilding, 2008).

The authors also underline issues related to measuring variables, e.g., shortcomings of the studies that result from the use of single-item measures of complex concepts, such as business strategy (Cadez, Guilding, 2008), or behavioural variable measurement, which relies on self-reported data (Thoradeniya et al., 2015; Johansson et al., 2016). Next, the sampling could potentially threaten the credibility of the results, for instance, the use of a convenience sampling technique or collecting data using self-reported measures from single respondents (Abdel-Maksoud et al., 2021). In some studies, the lack of data on the survey population prevented researchers from applying tests of representativeness to the sample (Shafer et al., 2016).

The underlined disadvantages of SEM are frequently the reasons why, in the final section of papers, the authors propose the use of other research methods, such as longitudinal field studies or multi-informant approaches, instead (Chong, Johnson 2007; Abdel-Maksoud et al., 2021). Additional investigations are demonstrated as an appropriate research approach to systematically explore the proposed theoretical causal relationships.

Discussion and conclusions

The benefits of SEM for researchers are the primary driving force behind its increased use in social science, including accounting. First, SEM is a useful technique for hypothesis testing, especially when testing *complex models* that combine extensive sets of variables based on large sets of assumptions. Second, SEM's *universality* and *flexibility* are underlined. The universality of application concerns theories to be tested or developed in the study, areas of interest (strategic management accounting, auditing, taxation), research strategies (not only survey-based but also archival or experimental research), and potential sets of research questions to be enquired. As demonstrated in Section 2.2, the heterogeneity of research topics is expanded from more traditional aspects of accounting research, such as the use of strategic management accounting (Cadez, Guilding, 2008) or

Simon's levers of control (Bastini et al., 2022), to the concepts of emotional intelligence (Yulianti et al., 2023), integrity (Tan et al., 2023) or data analytics (Sihombing et al., 2023). Within this discussion, it should be noted that the diversity and continual expansion of the range of topics and theories being explored can help clarify the extension of the boundaries of accounting as a field of study (Carnegie et al., 2021).

Furthermore, SEM is the type of research method that confirms the rapid development of automation in science and the creation of *e-science*, i.e., science based on automated processes, Artificial Intelligence (AI), and specialised software that supports researchers in constructing and verifying models (King et al., 2009; Sparkes et al., 2010; Johnson et al., 2021). SEM is inextricably linked to the application, selection, and development of software. Subsequent versions of SEM software not only make research more convenient for scholars but also increase the credibility and trustworthiness of the results. The increased automation of SEM research appears to be inevitable, and it is likely that literature searches required for hypothesis justification, operationalisation, and complex statistical analyses with final narrative conclusions will soon be automated. Automation technologies may also be useful in assisting scholars in theory building by identifying interesting relationships that need to be explained, writing reports, or even preparing texts according to the specific requirements of journals (Johnson et al., 2021). E-social science is an increasingly important component of current discussions on modern scientific research, including among accounting scholars. The automation of creative processes (Amabile, 2019) is already a matter of fact, not fiction.

SEM application also has interesting institutional aspects. SEM, as a research approach, is an example of the existence of *black boxing* in scientific inquiries. From the perspective of scholars (and perhaps reviewers as well), knowledge about the statistics behind SEM, e.g., indexes or tests that confirm the fit of the model, is less important as it is provided by specialised software used by the authors of previously published works. What is important in this dimension is the name and version of software used, which symbolically confirms the proper application of the method, the quality of the results, the reliability and validity of the outcomes, and, in consequence, the contribution that is assessed thoroughly by reviewers and editors.

In simple terms, SEM is a multivariate technique that combines selected aspects of multiple regression and factor analysis to estimate a series of interrelated dependence relationships simultaneously. Structure equation models allow for the use of multiple predictors and criterion variables, the construction of latent (unobservable) variables, the modelling of measurement errors for observed variables, and the testing of mediation and moderation relationships in a single model (Nitzl, 2016). As the SLR demonstrates, accounting scholars are increasingly applying SEM with an awareness of both the benefits and disadvantages of this approach. The universality of SEM-based research, the flexibility of its use, and the modest requirements for knowledge of statistics make SEM appealing to accounting scholars, irrespective of the area of interest, academic experience, or location. The results indicate that SEM is more readily used by researchers who

are not native English speakers, as the description of research and results are more standardised and software-supported. Nevertheless, it is important to remember the requirement to maintain the rigour of research and follow the best practices of scientific publications.

Although SEM is gaining popularity among accounting scholars, it is not widely used by Polish researchers, and, as the literature review revealed, SEM-based research rarely appears in Polish accounting journals. Thus, this paper is a kind of invitation to quantitative scholars to explore SEM and its potential. For instance, the dearth of SEM-based publications presents an opportunity for researchers who are keen to replicate prior studies under the specific conditions of the Polish economic and social environment, hence testing the boundaries of the ideas investigated in earlier studies. Moreover, this reflection on SEM and the constant development of entirely software-supported research is a contribution to the ongoing discussion on the future and potential of automated science based on robots, AI, and standardised procedures.

References

Abdel-Maksoud A., Jabbour M., Abdel-Kader M. (2021), *Stakeholder pressure, eco-control systems, and firms' performance: Empirical evidence from UK manufacturers*, "Accounting Forum", 45 (1), pp. 30–57, DOI: 10.1080/01559982.2020.1827697.

Al-Okaily M., Alkhwaldi A.F., Abdulmuhsin A.A., Alqudah H., Al-Okaily A. (2023), *Cloud-based accounting information systems usage and its impact on Jordanian SMEs' performance: the post-COVID-19 perspective*, "Journal of Financial Reporting and Accounting", 21 (1), pp. 126–155, DOI: 10.1108/JFRA-12-2021-0476.

Akter S., Fosso Wamba S., Dewan S. (2017), *Why PLS-SEM is suitable for complex modelling? An empirical illustration in big data analytics quality*, "Production Planning & Control", 28 (11–12), pp. 1011–1021.

Amabile T.M. (2020), *Creativity, artificial intelligence, and a world of surprises*, "Academy of Management Discoveries", 6 (3), pp. 351–354.

Bagozzi R.P., Yi Y. (2012), *Specification, evaluation, and interpretation of structural equation models*, "Journal of the Academy of Marketing Science", 40, pp. 8–34.

Bastini K., Getzin F., Lachmann M. (2022, *The effects of strategic choices and sustainability control systems in the emergence of organizational capabilities for sustainability*, "Accounting, Auditing & Accountability Journal", 35 (4), pp. 1121–1153, DOI: 10.1108/AAAJ-04-2020-4515.

Buaprommee N., Polyorat K. (2016), *Intention to purchase traceable meat: The impacts of perceived information asymmetry, informativeness, usefulness, and norm*, "Asian Journal of Business and Accounting", 9 (1), pp. 141–168.

Cadez S., Guilding C. (2008), *An exploratory investigation of an integrated contingency model of strategic management accounting*, "Accounting, Organizations and Society", 33 (7–8), pp. 836–863, DOI: 10.1016/j.aos.2008.01.003.

Carnegie G., Parker L., Tsahuridu E. (2021), *It's 2020: what is accounting today?* "Australian Accounting Review", 31 (1), pp. 65–73.

Chong V.K., Johnson D.M. (2007), *Testing a model of the antecedents and consequences of budgetary participation on job performance*, "Accounting and Business Research", 37 (1), pp. 3–19, DOI: 10.1080/00014788.2007.9730055.

Civelek M.E. (2018), *Essentials of structural equation modelling*, Zea E-Books, Lincoln, NB.

Coltman T., Devinney T.M., Midgley D.F., Venaik S. (2008), *Formative versus reflective measurement models: Two applications of formative measurement*, "Journal of Business Research", 61 (12), pp. 1250–1262.

Dash G., Paul J. (2021), *CB-SEM vs PLS-SEM methods for research in social sciences and technology forecasting*, "Technological Forecasting and Social Change", 173, 121092, https://doi.org/10.1016/j.techfore.2021.121092.

Deb B.C., Rahman M.M., Rahman M.S. (2022), *The impact of environmental management accounting on environmental and financial performance: empirical evidence from Bangladesh*, "Journal of Accounting & Organizational Change", 19 (3), pp. 420–446, DOI: 10.1108/JAOC-11-2021-0157.

Dhaifallah B., Md-Auzair S., Maelah R., Ismail M.D. (2020), *The effect of product complexity and communication quality on IOCM and OBA in buyer–supplier relationships*, "Journal of Accounting & Organizational Change", 16 (1), pp. 1–29, DOI: 10.1108/JAOC-04-2017-0035.

Ferri L., Spanò R., Ginesti G., Theodosopoulos G. (2021), *Ascertaining auditors' intentions to use blockchain technology: Evidence from the Big 4 accountancy firms in Italy*, "Meditari Accountancy Research", 29 (5), pp. 1063–1087, DOI: 10.1108/MEDAR-03-2020-0829.

Ghasemi R., Habibi H.R., Ghasemlo M., Karami M. (2019), *The effectiveness of management accounting systems: evidence from financial organizations in Iran*, "Journal of Accounting in Emerging Economies", 9 (2), pp. 182–207, DOI: 10.1108/JAEE-02-2017-0013.

Groen B.A. (2018), *A survey study into participation in goal setting, fairness, and goal commitment: Effects of including multiple types of fairness*, "Journal of Management Accounting Research", 30 (2), pp. 207–240, DOI: 10.2308/jmar-52072.

Hair J.F., Ringle C.M., Sarstedt M. (2013), *Partial least squares structural equation modeling: Rigorous applications, better results and higher acceptance*, "Long Range Planning", 46 (1–2), pp. 1–12.

Hair Jr J.F., Matthews L.M., Matthews R.L., Sarstedt M. (2017), *PLS-SEM or CB-SEM: updated guidelines on which method to use*, "International Journal of Multivariate Data Analysis", 1(2), pp. 107–123.

Ittner C.D., Larcker, D.F. (1997), *Quality strategy, strategic control systems, and organizational performance*, "Accounting, Organizations and Society", 22 (3–4), s. 293–314.

Jesson J.K., Metheson L., Lace F. (2011), *Doing your literature review – traditional and systematic techniques*, Sage Publications, Thousand Oaks, CA.

Jodie B.U., Ullman B. (2006), *Structural equation modeling: reviewing the basics and moving forward,* "Journal of Personality Assessment", 87 (1), pp. 35–50.

Johansson T., Siverbo S., Camén C. (2016), *Managing cooperation, coordination, and legitimacy: Control of contracted public services,* "Accounting, Auditing & Accountability Journal", 29 (6), pp. 1012–1037, DOI: 10.1108/AAAJ-08-2014-1805.

Johnson C.D., Bauer B.C., Niederman F. (2021), *The automation of management and business science*, "Academy of Management Perspectives", 35 (2), pp. 292–309.

Kaplan D. (2008), *Structural Equation Modeling: Foundations and Extensions*, Sage Publications, Thousand Oaks, CA.

King R.D., Rowland, J., Oliver S.G., Young M., Aubrey W., Byrne E., Liakata M., Markham M., Pir P., Soldatova L.N., 2009, *The automation of science*, "Science", 324 (5923), pp. 85–89.

Kline R. (2011), *Principles and Practice of Structural Equation Modelling*, The Guilford Press.

Lee L., Petter S., Fayard D., Robinson S. (2011), *On the use of partial least squares path modeling in accounting research*, "International Journal of Accounting Information Systems", 12 (4), pp. 305–328.

Lewis-Beck, M., Bryman A. E., Liao T. F. (2004), *The Sage Encyclopedia of Social Science Research Methods*, Sage Publications, Thousand Oaks, CA.

Maryam S., Sule, E.T., Ariawaty R.N. (2021), *Effects of Safety Climate and Employee Engagement towards Organisational Citizenship Behaviour of Sewage Workers*, "Asian Journal of Business and Accounting", 14 (1), pp. 253–275, DOI: 10.22452/ajba.vol14no1.10.

Meier J.H., Esmatyar W. (2016), *Managerial Optimism and the Cost of Capital. The SEM-Approach with a Focus on the German Capital Market*, "Zeszyty Teoretyczne Rachunkowości", 86 (142), pp. 119–134.

Mir F.A., Rezania D. (2022), *From interactive control to IT project performance: examining the mediating role of stakeholder analysis effectiveness*, "Journal of Accounting & Organizational Change", 18 (5), pp. 727–751, DOI: 10.1108/JAOC-04-2021-0048.

Mueller R. (1997), *Structural equation modelling. Back to basics*, "Structural Equation Modelling: A Multidisciplinary Journal", 4 (4), pp. 353–369.

Namazi M., Rezaei G. (2023), *Modelling the role of strategic planning, strategic management accounting information system, and psychological factors on the budgetary slack*, "Accounting Forum", pp. 1–28, DOI: 10.1080/01559982.2022.2163040.

Narayanan A. (2012), *A review of eight software packages for structural equation modelling*, "The American Statistician", 66 (2), pp. 129–138.

Nitzl C. (2016), *The use of partial least squares structural equation modelling (PLS-SEM) in management accounting research: Directions for future theory development*, "Journal of Accounting Literature", 37 (1), pp. 19–35.

Rahi S., Abd. Ghani M. (2019), *Integration of DeLone and McLean and self-determination theory in internet banking continuance intention context*, "International Journal of Accounting & Information Management", 27 (3), pp. 512–528, DOI: 10.1108/IJAIM-07-2018-0077.

Sarikhani M., Ebrahimi F. (2022), *Whistleblowing by accountants: an integration of the fraud pentagon and the extended theory of planned behaviour*, "Meditari Accountancy Research", 30 (6), pp. 1740–1763, DOI: 10.1108/MEDAR-10-2020-1047.

Shafer W.E., Park L.J., Liao W.M. (2002), *Professionalism, organizational-professional conflict and work outcomes: a study of certified management accountants*, "Accounting, Auditing & Accountability Journal", 15(1), pp. 46–68, DOI: 10.1108/09513570210418888.

Shafer W.E., Simmons R.S., Yip R.W. (2016), *Social responsibility, professional commitment and tax fraud*, "Accounting, Auditing & Accountability Journal", 29 (1), pp. 111–134, DOI: 10.1108/AAAJ-03-2014-1620.

Shook C.L., Ketchen Jr D.J., Hult G.T.M., Kacmar K. M. (2004), *An assessment of the use of structural equation modeling in strategic management research*, "Strategic Management Journal", 25 (4), pp. 397–404.

Sihombing R.P., Agustia D., Soewarno N. (2023), *The mediating effect of data analytics on the relationship between organizational psychological safety and advisory services*, "Managerial Auditing Journal", 38 (4), pp. 337–353, DOI: 10.1108/MAJ-04-2022-3521.

Sparkes A., Aubrey W., Byrne E., Clare A., Khan M.N., Liakata M., Markham M., Rowland J., Soldatova L.N., Whelan K.E., (2010), *Towards robot scientists for autonomous scientific discovery*, "Automated Experimentation", 2 (1), pp. 1–11.

Staniec I. (2018), *Modelowanie równań strukturalnych w naukach o zarządzaniu*, „Organizacja i Kierowanie", 2 (181), pp. 65–77.

Taha A.A. (2023), *Internal auditors' independence under workplace bullying stress: an investigative study*, "Journal of Islamic Accounting and Business Research", Vol. ahead-of-print, No. ahead-of-print, DOI: 10.1108/JIABR-09-2022-0239.

Tan K.L., Liu Y., Ye Q. (2023), *A gendered discourse on truthful disclosure of financial fraud practices among accountants in China: implications to corporate governance*, "Accounting Research Journal", 36 (2/3), pp. 230–250, DOI: 10.1108/ARJ-07-2022-0160.

Tarka P. (2018), *An overview of structural equation modeling: its beginnings, historical development, usefulness and controversies in the social sciences*, "Quality & Quantity", 52, pp. 313–354.

Thoradeniya P., Lee J., Tan R., Ferreira A. (2015), *Sustainability reporting and the theory of planned behaviour*, "Accounting, Auditing & Accountability Journal", 28 (7), pp. 1099–1137, DOI: 10.1108/AAAJ-08-2013-1449.

Uyar A., Kuzey C. (2016), *Contingent factors, extent of budget use and performance: A structural equation approach*, "Australian Accounting Review", 26v(1), pp. 91–106, DOI: 10.1111/auar.12090.

Van der Kolk B., van Veen-Dirks P.M., ter Bogt H.J. (2019), *The impact of management control on employee motivation and performance in the public sector*, "European Accounting Review", 28 (5), pp. 901–928, DOI: 10.1080/09638180.2018.1553728.

Westland J.C. (2015), *Structural equation models*, "Studies in Systems Decision and Control", 22 (5), p. 152.

Williams L.J., Vandenberg R.J., Edwards J.R. (2009), *12 structural equation modeling in management research: A guide for improved analysis*, "Academy of Management Annals", 3 (1), pp. 543–604.

Yulianti Y., Zarkasyi M.W., Suharman H., Soemantri R. (2023), *Effects of professional commitment, commitment to ethics, internal locus of control and emotional intelligence on the ability to detect fraud through reduced audit quality behaviors*, "Journal of Islamic Accounting and Business Research", Vol. ahead-of-print, No. ahead-of-print, DOI: 10.1108/JIABR-02-2021-0076.