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Motivation to use Big Data and Big Data Analytics in external auditing

Abstract

Purpose—The paper aims to explore organisational intentions to use Big Data and Big Data Analytics (BDA) in external auditing. This study conceptualises different contingent motivating factors based on prior literature and the views of auditors, business clients and regulators regarding the external auditing practices and BDA.

Design/methodology/approach—Using the contingency theory approach, a literature review and 21 in-depth interviews with three different types of respondents, we explore factors motivating the use of BDA in external auditing.

Findings— Our study presents a few key findings regarding the use of BD and BDA in external auditing. By disclosing a comprehensive view of current practices, we identify two groups of motivating factors (company related and institutional), and the circumstances in which to use BDA, which will lead to the desired outcomes of audit companies. In addition, we emphasise the relationship of audit companies, business clients and regulators. Our research indicates a trend whereby external auditors are likely to focus on the procedures not just to satisfy regulatory requirements, but also to provide more value for business clients; hence, BDA may be one of the solutions.

Practical implications— Current practices and outcomes of using BD and BDA by different types of respondents differ significantly. We wish to emphasise the need for audit companies to implement a BD-driven approach and to customise their audit strategy to gain long-term efficiency. Furthermore, the most challenging factors for using BDA emerged, namely long-term audit agreements, and the business clients' sizes, structures and information systems.

Originality/value—The original contribution of this study lies in the empirical investigation of the comprehensive state-of-the-art of BDA usage and motivating factors in external auditing. Moreover, the study examines the phenomenon of Big Data as one of the most recent and praised developments in the external auditing context. Finally, a contingency-based theoretical framework has been proposed. In addition, the research also makes a methodological contribution by using the approach of constructivist grounded theory for the analysis of qualitative data.

Keywords: Big Data, Big Data Analytics, external auditing, contingent factors

Article classification: Research paper

1. Introduction

In the past several years, the technology of Big Data (BD) has gained remarkably in popularity within a variety of sectors, ranging from business and government to scientific and research fields (Ajana, 2015). The area of accounting and auditing is not an exception, as companies are confronted by an unprecedented level of semi-structured and unstructured massive data, which companies have to use and manage in order to be innovative, effective and competitive. On one hand, we can see excitement about BD emerging due to the recognition of opportunities in various areas (Marshall *et al.*, 2015; Verma and Bhattacharyya, 2017; Vera-Baquero *et al.*, 2015; Enget *et al.*, 2017). On the other hand, the concept of BD is still confused (for example, social media data or business data) (Connelly *et al.*, 2016; Harford, 2014) and quite vague in terms of the circumstances of use.

According to Wang and Cuthbertson (2015), the potentially important role played by BD and Big Data Analytics (BDA) in innovative auditing practice is evident. Quite a few studies have discussed and analysed broad areas of BD and BDA in external auditing by explaining and providing a context for researchers, drawing their attention to it in terms of general issues (Alles and Gray, 2016; Alles, 2015; Earley, 2015; Wang and Cuthbertson, 2015; Arnaboldi, 2017; Connelly *et al.*, 2016), as well as arguing that the use of BDA is appropriate and valuable to ensure the audit quality (Dubey and Gunasekaran, 2015; Brown-Liburd *et al.*, 2015; Vasarhelyi *et al.*, 2015). BDA may improve the efficiency and effectiveness of financial statement audits (KPMG, 2017; Cao *et al.*, 2015; Yoon *et al.*, 2015; Gepp *et al.*, 2018), but additional competencies and technological capabilities are necessary to implement BDA (KPMG, 2017; Enget *et al.*, 2017; Dubey and Gunasekaran, 2015; Brown-Liburd *et al.*, 2015; Zhang *et al.*, 2015; Appelbaum *et al.*, 2017, 2018).

Nonetheless, auditing is lagging behind the other research streams in the use of valuable BDA (Gepp *et al.*, 2018). However, research on understanding the motives for using BDA is limited, as current studies do not attempt to explain why audit companies should actually use BDA. Hence, an external audit is analysed from two process points of view — the audit process between the audit company and client, and the audit process between the audit company and regulatory bodies. In fact, BD only became accessible recently through powerful analytical tools, but there are no obvious institutional forces that use BD information or to implement BDA at corporate level. The problematisation proposed in the paper is the result of a dialectical interrogation (Alvesson and Sandberg, 2011) of audit companies, business clients and regulatory bodies, and the domain of literature targeted to challenge assumptions. The use of innovative analytical tools such as BDA may cause a tension among audit companies, business clients and regulators. This aspect arises because of interdependence in the auditing process.

The previous literature has stipulated several contingent factors (namely company size, strategic orientation, modern technologies and regulatory environment) that can strengthen or pose challenges to the use of BDA in external auditing. We elaborate on different operating factors, as underlying theoretical assumptions, relevant to consider their difference influences on different stages of financial auditing, including the actors in financial auditing. Based on these assumptions, we raise the following research question: What factors influence the motivation to use BDA in external auditing and how intensively are these factors expressed by audit companies, business clients and regulators?

The main contributions of this paper are the following. To the best of our knowledge, we are among the first to study the comprehensive state-of-the-art of BDA usage, the motivating factors and the potential outcomes for audit companies empirically. We explain how different institutional and company-related factors are expressed and influence the decision of whether to use BDA in external auditing. In particular, we focus on the phenomenon of BD in external auditing by observing the views of diverse participants (namely audit companies, audit clients and audit regulators). Prior literature that examined audit analytics focused mainly on single influencing factors without taking the entire contingency-based view into account. This study investigates the use of BDA in external auditing from the perspective of contingency theory. In addition, the study also makes a methodological contribution by introducing the use of the constructivist grounded theory approach within the context of a novel research question, for which the existing literature and data are generally lacking.

The paper is organised as follows. The literature review and the theoretical framework pertaining to BDA use in an external auditing are presented in the second part of this paper. The third part presents the methodology used, while the fourth part presents the results and

the findings from the interviews. The discussion and conclusion are presented in the last part of this paper. Research limitations and further research directions are also provided.

2. Literature review and theoretical framework

2.1. Literature review of Big Data Analytics in external auditing

During the last few years, researchers have produced an impressive amount of general reviews, conceptual and research papers in an attempt to define the concept of BD and Data Analytic tools. The 3Vs (volume, variety and velocity) are the three best-known defining dimensions of BD. Laney introduced the 3Vs concept in a 2001 MetaGroup research publication, *3D data management: Controlling data volume, variety and velocity*. In much of the business research, BD is seen as a new opportunity to enhance productivity, efficiency and innovativeness in companies (Sheng *et al.*, 2017; Verma and Bhattacharyya, 2017; Connelly *et al.*, 2016; Marshall *et al.*, 2015; Vera-Baquero *et al.*, 2015; Ajana, 2015).

Overall, the emergence of BD is both promising and challenging for social research, as well as for the accounting and auditing areas, which are regarded as intrinsically data intensive. According to Warren *et al.* (2015), BD will have increasingly important implications for accounting ecosystems in all senses, even as new types of data become accessible, as will the inherent technological paradoxes of BD and corporate reporting (Al-Htaybat and Alberti-Alhtaybat, 2017; Bhimani and Willcocks, 2014), and new performance indicators based on BD (Arnaboldi *et al.*, 2017).

In general, auditors work with structured financial data; however, the volume and complexity of business companies require even more rapid and sophisticated information and analyses of unstructured or semi-structured non-financial BD from both internal and external sources. In external auditing, BD may be conceptualised as an additional information resource that has a direct effect on the understanding about the environment of the business client and the performance of an audit. Moreover, the inclusion of BD may contribute to the development and evolution of effective BDA tools and changes in the audit processes.

BDA is the process of inspecting, cleaning, transforming and modelling BD to discover and communicate useful information and patterns, suggest conclusions and support decision making (Cao *et al.*, 2015) by using "smart" algorithms (Davenport, 2014). According to Wang and Cuthbertson (2015), the potential of BDA to improve the practice of auditing is quite significant. A detailed literature review is commonly accepted as the beginning step in research, and is important to indicate relevant research in a field. Accordingly, this research began with a literature review of the fields of BD, BDA and auditing. Research synthesis was selected as the method for the literature review with the aim of utilising the existing literature (Cooper *et al.*, 2009; Dixon-Woods *et al.*, 2005). The literature review outlines a few main directions and possible influences of BDA in the context of auditing. A major research stream in the field argues that use of BDA is useful and valuable for ensuring audit quality (Cao *et al.*, 2015; Dubey and Gunasekaran, 2015; Brown-Liburd *et al.*, 2015; Yoon *et al.*, 2015; Vasarhelyi *et al.*, 2015) by improving the efficiency and effectiveness of financial statement audits, as well as by using BD as audit evidence.

A second stream of research focuses on additional competences that are necessary to ensure an effective process when using BDA (Dubey and Gunasekaran, 2015). The latest research by McKinney *et al.* (2017), Enget *et al.* (2017), Janvrin and Weidenmier Watson (2017) and Sledgianowski *et al.* (2017) emphasise the need to incorporate issues of BD and BDA into the accounting curriculum by acknowledging that these technologies are transforming the accounting profession (Enget *et al.*, 2017; Fay and Negangard, 2017; Brown-Liburd *et al.*, 2015; Zhang *et al.*, 2015).

A third stream of research emphasises the role of changes in auditing standards. On one hand, Appelbaum *et al*. (2017) argued that the standards themselves do not forbid the use of BDA, but that the economics of external audits make analytics more difficult or nearly impossible to use. On the other hand, the key methodological problem is using BD as audit evidence (Brown-Liburd and Vasarhelyi, 2015). According to the standards, BD evidence should be considered as less reliable for audit evidence (Appelbaum, 2016). Hence, changes in the methodological audit approach, a change in standards to focus on data, the processes that generate them and the analysis thereof, changes in the nature of accounting records and auditing domains will add value and relevance to the accounting profession (KPMG, 2017; Krahel and Titera, 2015, Vasarhelyi *et al.*, 2015; Gray and Debreceny, 2014). Moreover, updated standards may help to overcome the auditing profession's apparent reluctance to engage with BDA (Gepp *et al*., 2018).

Finally, a fourth stream of research explains the technological challenges for companies of using BDA, with the focus on continuous auditing technology (Rikhardssona and Dull, 2016; Appelbaum *et al*., 2016; Sun *et al.*, 2015; Chen and Wang, 2015; Alles, 2015; Chiu *et al.*, 2014) and BD techniques (Gepp *et al*., 2018; Appelbaum *et al*., 2017). Moreover, according to the literature review, Appelbaum *et al*. (2018) classified the audit analytics used in the various audit stages. As external auditing is inseparable from the characteristics of business clients, Al-Htaybat and Alberti-Alhtaybat (2017) identified the inherent technological paradoxes of using BD in corporate reporting.

According to literature review, it could be stated that the main streams of research focus on and disclose the outcomes and value of the use of BDA in external auditing, the aspects that have an influence on the efficient use of BDA and discuss the interaction between BD and traditional sources of data, as well as BD's impact on audit judgement and behavioural research. It could also be stated that external conditions and the environment have an influence on the use of BDA in external auditing. On the other hand, the research could be described as fragmented, disclosing different but limited aspects that motivate or challenge the use of BDA in external auditing, and a complete list of motivation factors influencing the use of BDA in external auditing has not been researched.

2.2. The theoretical framework

Contingency theory focuses on how elements must fit together to reach the desired configuration, as well as the forms of fit, as proposed by Venkatraman (1989). In fact, the contingency-based approach that is used widely in management research (Chenhall, 2003; Chapman, 1997; Ittner and Larcker, 1997) could be also applied to explain audit companies' intentions to adopt analytical tools at the corporate level.

Considering the complexity and dynamism of the audit process, the necessity of using BDA might be influenced by different, contingent, external and internal factors. Auditors require access to documents, systems, policies and procedures to manage an audit. They must remain compliant with accounting and auditing standards, government regulations and internal requests. Audit teams may begin the audit process with meetings during which they gain risk and control awareness. Auditors perform substantive procedures and test controls, and then draft reports that they submit to management and regulatory authorities (Davoren, 2016). Many contingency variables have been found to be relevant, including the environment – in particular, environmental uncertainty and market competition (Otley, 2016), technology (Otley, 1980, 2016; Chenhall, 2003), national culture (Ahmad and Schroeder, 2003; Flynn and Saladin, 2006; Otley, 2016), strategic context (Wickramasinghe and Alawattage, 2007; Sila, 2007), and company size and structure (Otley, 2016; Wickramasinghe and Alawattage, 2007). While it is possible that all these play an important

role in the design of control systems (Brivot *et al*., 2017), this paper focuses particularly on the main contingent factors that have been subject to investigation, namely the environment, technology, strategic context, size and structure. The contingency of natural culture has not been taken into consideration.

Environment, as a contingency factor, may constitute the market and its associated factors, such as prices, products, competition, government policies and so on (Wickramasinghe and Alawattage, 2007). *Environment* (as a contingency) may constitute the audit market's uncertainty and its associated factors, such as audit fees, competition and regulators' policies, such as the attitudes of those setting the standards (Li *et al*., 2018). Looking at the BDA's influence from the external auditing point of view, audit market regulators play a particularly important role in ensuring audit companies' public quality aspects and enhancing the use of data analytic tools.

Technologies can be understood as the processes used by companies to convert inputs into outputs (Khandwalla, 1977). When a company fails to match its technology to its structure, it does not succeed as a sustained organisation (Wickramasinghe and Alawattage, 2007). In audit companies, *technologies* involve both knowledge and techniques. Moreover, technology, as a contingent factor, refers to the so-called hard IT-related aspects adopted by companies (Garengo and Bititci, 2007). Hence, BDA, as an IT tool, may have a direct impact on the audit process by influencing the audit phase of engagement. BDA may have an indirect impact on the audit planning phase, as audit strategies and audit plans are developed according to the data and information coming from the analysis of client's environment. BDA, as an IT tool, may also have a direct influence on compliance and substantive testing, as well as on evaluations and reports. Overall, the need to use BDA may depend on the requirements of the audit regulatory bodies and business clients, as well as on internal technological capabilities, IT-related managerial activities, such as the internal investments in hardware and software, external consultants and so on (Tarek *et al*., 2017).

Based on the notions of contingency theory, researchers have discussed how the fit between environment and strategy can influence organisational performance. Thompson (1967) argued that changes in technology and environmental factors resulted in differences in structures, strategies and decision processes. Henderson and Mitchell (1997), Spanos and Lioukas (2001) and Johnson and Scholes' (2008) research results supported the argument that strategy was one of the effects that had influence as a significant determinant of performance. Pateli and Giaglis (2005) developed a structured approach to changing the business model of a company (including strategy perspective), which introduced a technological innovation by keeping the principles of the old (traditional) business logic and taking the effects incurred from the firm's internal and external environment into account. With reference to contingency theory, it might be suggested that *strategic orientation* could have a significant influence in persuading audit companies to use BDA in auditing process in an attempt to find the fit among new trends in technology, the environment and organisational strategy. Referring to contingency theory, one might suggest that *strategic orientation* could influence audit companies to use BDA in auditing process significantly. A BD-based approach is inseparable from the corporate core strategy and aims. As suggested by Gepp *et al*. (2018), long-term orientation towards the use of BDA may outline future opportunities for auditing in the context of real-time information, and on collaborative platforms and in peer-to-peer marketplaces.

Size has also been found to be an important contingent factor in understanding the nature of organisational structures and behaviour (Wickramasinghe and Alawattage, 2007; Otley, 2016). This implies that audit companies need to pay attention to the size of the audit company itself and to that of the business client when creating an audit strategy and plan. According to contingency theory, large companies have extensive specialisation,

standardisation and formalisation, but these features are less important in small companies (Wickramasinghe and Alawattage, 2007); thus, it could be stated that small clients might not be able to provide all the necessary information as BD for further analysis and the application of BDA tools. Furthermore, small audit companies might not be able to use BDA for their business clients because of a lack of trained staff and limited technological capabilities.

Structure refers to the establishment of certain relationships among people with specified goals and tasks (Wickramasinghe and Alawattage, 2007). A poorly fitting structure is nothing else but a waste of resources, and leads to the ultimate collapse of the business (Mintzberg, 1987; Otley, 2016). Accordingly, it could be stated that different methods, instruments, functions and processes cannot be designed without finding the best structure alignment. From a BDA point of view, it might be assumed that a suitable and organic structure would be able to support the implementation of innovative analytical tools in audit companies, and vice versa.

The literature describes several factors that can strengthen or pose a challenge to the use of BDA in external auditing by integrating them in a theoretical framework (Figure 1).

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Figure 1

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The theoretical framework contains key participants involved in the auditing process (audit companies, business clients and regulators), the auditing process (where BDA might appear in different phases of an audit) and the contingent factors discussed above.

3. Research methodology

Based on the literature review, we explored different contingent factors that may motivate the use of BD and BDA in external auditing theoretically. Qualitative research (Birkinshaw *et al*., 2011) adopted the constructivist grounded theory approach as described by Charmaz (2006, 2014) for two main reasons:

(1) BD and BDA are rarely researched phenomena within the field of auditing, and we were motivated to understand "the actual production of meanings and concepts used by social actors in real settings" (Gephart, 2004, p. 457), and

(2) we aimed to develop theoretical insights into a process about which there is little extant theorising or empirical knowledge (Suddaby, 2006).

This research uses the analysis approach suggested by Strauss and Corbin (1990) to present rich and detailed descriptions, which allows the reader to make sufficient contextual judgements to transfer the interview findings to alternative settings.

We followed the main stages in grounded theory research for qualitative data analysis (McNabb, 2008; Corley, 2015), namely collecting data, open coding, axial coding and developing theoretical insights.

3.1. Data collection

The research on the motivation to use BDA in external audits was conducted using semi-structured interviews to allow for follow-up questions. Interview questions derived from theory are the tools used to obtain information that will help to answer the research question (Glesne, 2006).

The respondents were selected on the basis of two considerations: (1) the company, and (2) the respondent's position. With regard to the first consideration, the companies that were

selected as the three case studies were selected an audit network company dealing with DA, a business client company dealing with BD and a regulator. This selection was intended to obtain different perspectives on the same phenomenon. Table 1 shows the description of the sample.

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Table 1

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For the second consideration, the respondents were selected according to their positions in the company. Hence, the respondents were auditors and BD analysists working and dealing with the company's data. The selection of the participants, as different stakeholders, was also intended to improve the validity and reliability of the study (Yin, 2003).

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Table 2

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During the face-to-face interviews, which lasted for 35 minutes on average, the participants were given a copy of the interview guide (questionnaire see Annex 1) in order to ensure sufficient coverage of the research aim and the optimal use of time.

Part one was related to the background information and general understanding of BD in the company, and the motivating factors for using BDA. The second part was related to the practical aspects of using BDA in the audit process. The proposed questions included 'why' and 'how' information, and respondents were asked to discuss the reasons, motivations, creation, implementation and use processes of BDA, including values, its challenges and the possible changes for the auditing process.

The interviews were tape recorded with prior permission from the participants after they signed an official agreement. Towards the end of each interview, time was allowed for open and informal discussions in order to extract information that participants might otherwise have been reluctant to provide during the formal interview sessions. Overall, the interviews lasted for 12 hours and 38 minutes, resulting in 156 pages of transcripts. The interviews were conducted in Lithuanian or English. Data were collected and analysed in 2015-2017, except for the interview with the BDA analyst from the audit company, which was conducted and analysed in 2018.

3.2. The setting of the Lithuanian audit market

We focus next on the description of the setting of the Lithuanian audit market as a critical factor for the analysis and interpretation of the data.

The Lithuanian audit market is relatively young and concentrated. In 2009, the National Audit Standards were abandoned, and only the International Standards on Auditing have been applied since. According to the data from the Lithuanian Chamber of Auditors of February 1, 2017, 357 auditors and 170 audit companies have been certified, of which 141 out of 170 audit companies were listed as very small companies, 25 audit companies as small companies, four audit companies as medium companies and one audit company as large.

In 2015, Lithuanian audit companies conducted 4217 audits in total, including 3898 financial statement audits in Lithuania, 273 audits on consolidated financial statements in Lithuania, 44 audits on interim financial statements in Lithuania and two audits abroad

(Lithuanian Chamber of Auditors Report, 2015). Among the clients of audit companies, the current companies include public interest entities and companies that are legally required to carry out audits but, in general, there are not many large clients.

The audit market in Lithuania is concentrated – the 10 largest audit companies, according to the received revenue from audit activities in 2015, accounted for almost 70% of the audit market. The average fee per audit performed in 2015 amounted to 4143,04 EUR. The highest average fee for one audit was for the companies in the Big 4 - 8698,50 EUR, which is four times higher than it was for audit companies with one or two auditors, and three times higher than it was for audit companies with three or more auditors (Lithuanian Chamber of Auditors Report 2015). However, given the fact that the audit companies for the Big 4 spend most of their time on audits, the difference in the average fee for the audit service is lower. Significant fluctuations in the fees for services between international and smaller national audit companies are typical of the Lithuanian audit market. This situation can also be explained by the fact that international networking audit companies are auditing the largest and, at the same time, the most complex business companies.

3.3. Coding and analyses

Preliminary coding on the basis of the 21 interviews was developed first. After the transcription of all the interviews was completed, all the transcripts were analysed by both researchers separately via a systematic process of coding and categorisation intended to group the information from the transcripts into similar concepts or themes that emerged from the analysis. We then discussed the open coding of sentences or paragraphs within the transcripts to identify key concepts emerging from the data and to link them to what allowed agreeing on a certain open codes. Table 3 illustrates the open coding of the interview transcripts.

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Table 3

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During the process of our further discussions and analyses, open codes were assigned to broader categories, called second-order codes, which highlighted the relationships among the open codes (Lee, 1999). These second-order codes were then used to create broader categories — axial codes - to facilitate theoretical insights (Lee, 1999), such as Current Practices, Company Factors, Institutional Factors and Outcomes. Table 4 shows the axial codes and the descriptions thereof.

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Table 4

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Coding process and codes, as a method of qualitative data analysis, (McNabb, 2008; Corley, 2015) allowed for the identification of key concepts emerging from the qualitative data – the transcripts. Meaningful results and findings are presented on the basis of axial codes, which indicated the main groups of motivating factors for and the circumstances in which to use BD and BDA in external auditing.

4. Results and findings

After careful consideration of the second-order and axial codes, 'Current Practices' was organised to include the open codes of Experience, Benefits, Financial Resources and Increasing Trend, which were identified as having similarities based on their currently existing features. During the data analysis process, the second-order and axial code 'Institutional Factors' was organised using open codes such as Regulation System, Market Structure and Education. Three open codes, namely Strategic Decisions, Governance Structure and Size were identified as a second-order code Strategy-related Factors, and three open codes, namely Information System, Competent Teams and Internal Capabilities were identified as a second order code, 'Resource-related Factors'. These two second-order codes were then used to create a broader category, namely the axial code 'Company Factors'. There were three open codes, which were Planning, Management and Reporting, which were integrated based on their properties in a second order code, 'Internal Control'. Five open codes were Understanding the Client's Company, Audit Planning, Audit Performance and Conclusion, and Audit Team and Audit Fee were identified as having similarities; thus, they were combined in a second-order code, 'Audit Process'. In addition, the open codes Audit Quality and Control of Audit Quality were combined in a second-order code, 'Quality'. These three second-order codes were identified as having similarities, in the main areas that are influenced by the use of BD / BDA in business and audit companies, and were combined in an axial code, 'Outcomes'.

The results are presented from the different respondent groups' points of view.

4.1. Audit companies

Current practises*. Experience.* Large audit companies (international networks) develop and apply analytic tools that are similar to the BDA content-wise and complexity-wise. On average, audit companies have applied modern analytic tools for two to four years in the Baltic region. The auditors emphasise that the application of such innovative data analytics in the Baltic region is actually not the first choice (as compared to the USA, the UK, Germany or some Asian countries' audit markets, for example). Big 4 auditors shared similar practices:

> We are a smaller country; therefore, we usually do not even get on the first wave of implementation and application of innovative data analytics (Big 4 (2)).

However, some experts emphasised that companies had only taken the first steps in analysing BD context, referring to the demand for BD-based tools:

> We are making first steps but the practical implementation is not for today yet. […] We are developing applications, methodology. Some regions are more advanced, like North America, UK or Asia. We [Lithuania] are more like recipients of innovations (Big 4 (1)).

Other experts confirmed that audit companies had already made a progress in developing and applying analytical tools, and had started to use the more advanced versions in Lithuania:

> [...] as we implement audit analytical tools very purposefully, now we develop and implement a new and advanced analytical tool which was created and developed in UK office of our company (International audit network).

Increasing trend. Conducting a BDA-based audit was a challenge for the auditors themselves:

A possibility to audit all data is even now hardly perceivable for some auditors, as big companies' audits are based on sampling methods. […] With technologies, a huge amount of information in an external audit does not play such an important role (Big 4 (1)).

Implementing BD technology-based tools establishes the conditions for changing the thinking and attitudes of both auditors and business clients. In the case of a client being a small business company, audit companies even have to show the value of using BDA in the audit process:

We indicate the main advantages of using BDA for our small or new clients [*such as*] using BDA we will be able to indicate the systemic problems and variances in your [*business*] company data, increase the quality of audit report and to find the fraud events (International audit network).

Benefits. The largest audit companies (international networks) assessed the BD and BDA unambiguously positively, and treated them as a competitive advantage in the audit market in the long term. Enabling auditing technologies will probably foster the competitiveness of all audit companies in the oligopoly audit market:

[...] currently, analytics tools are used considerably more, as also our company itself has invested a lot into these new analytics tools. We think that Big 4 (2) Eagle [analytical tool] is a competitive advantage. [...] Unambiguously positive, as it helps to focus on riskier fields. It helps to identify the fields that might look suspicious (Big 4 (2)).

Financial resources. Small audit companies usually only apply very simple analytical tools, mainly because of lack of knowledge, poor financial resources and the cost of investment. The current practices of small- and medium-sized national audit companies and audit companies that belong to international networks strongly diverge with regard to applying modern technologies.

[…] by investing in analytical tools we always measure costs […] as it's really very expensive (Big 4 (3)).

[…] notwithstanding huge financial recourses needed, all investments are very useful. We operate in a very competitive business environment where we have to make our processes more efficient in order to compete with a lower price. […] Technologies help to work efficiently and save costs (International audit network).

The largest companies were usually more experienced in the use of data analytics and were already gaining advantages because of the economy of scale.

Institutional factors. *Regulation system*. Institutional factors affect audit companies themselves through the requirements for the performance of more efficient audits (application of control tests and detailed procedures) and quality control. Hence, the importance of International Standards on Auditing (ISA) is evident. Audit companies also have an impact via the client, such as additional legislative requirements for the quality of accounting and clients' accounting IS.

If audited clients are small, their accounting IS will naturally be distinguished by a smaller quantity of structured and non-structured data. The size of the client is also associated with the fee for the audit. In fact, no companies in the Baltic region are big globally; therefore, strong competition in terms of price is prevalent.

[...] clients are too small, because if we talk about analytical tools, we encounter limitations, one of which is the size of the client, and then this is closely associated also with price limitations (Big 4 (2)).

Although Krahel and Titera (2015) and Vasarhelyi *et al.* (2015) argued that the application of BDA would also bring about changes in ISA, audit experts did not think that auditing

standards and methods should necessarily change for the successful employment of these analytic tools. Current legal acts are sufficient to conduct a BD-based audit.

Audit standards that have these requirements already require all companies to conduct an audit in the most effective way using the analytics tools. This is simply another tool to achieve these goals in a faster and better way. But this does not change the way that an audit team should work, what the work principles are, how we plan, organise, review and what the quality control is (Big 4 (2)).

Standards are nevertheless a set of principles, not rules. As regards an understanding of the company, control environment and all processes, it is already laid down in the standards that you have to understand all processes, irrespective of whether you will subsequently validate the control or not, and whether you are going to trust them (Big 4 (4)).

Thus, auditing standards are focused on the audit's purpose and general principles, not on the techniques/analytics that are used to perform it.

Market structure. It is important to note that the market orientation of client's company may also determine the use of BD technologies, as well as the market's size.

Lithuania is not a big market size. If companies are just orientated to the Lithuanian market, it is not large enough. They do not require substantial systems that would work with crazy amounts of data. […] On the other hand, more and more service centres are being established in Lithuania [*banks, sharing centres* (explanation added)]. … The driver would be management established in a foreign country (Big 4 (1)).

Education. One of the most important aspects when attempting to apply BDA successfully is having competent employees. Education plays a critical role in providing audit specialists with interdisciplinary competence.

[…] even the universities themselves should focus more on IT by preparing specialists. It is a big challenge for us. We can see IT specialists who do not care anything about accounting, and graduated accountants who have poor skills in IT. Unfortunately, we do not see the merger. […] So we are already looking for people with integrated skills (Big 4 (1)).

By developing and implementing BDA we saw the transformation in the audit profession and it's not enough to be only an accountant or auditor but we also need to have IT competences… (International audit network).

As requirements for external auditor's professional competence are set by public authorities, there may be inevitable changes in the long run.

Company factors. *Strategy-related factors*. The use of modern analytics in large network audit companies, including international audit networks, is based on the global strategy of IT innovations:

No large companies stand still, and, talking about our company, this is a really global network investing in these technologies. [...] there exists a common global strategy and a vision of the company, when we all [units in different regions] will start using a particular analytics tool (Big 4 (2)).

To be a part of a global business, and to belong to international networks, plays an important role in using BD in external auditing and the client's performance:

Most of the businesses, especially IT businesses, are foreign owned. They are driven by a parent company. […] So, the ownership structure is an important factor (Big 4 (1)).

The motivation of audit companies to invest in analytics tools relies primarily on the size of the company and its strategic orientation. International audit networks and large audit companies have greater possibilities of creating or acquiring such powerful analytics tools:

We do not develop such analytics tools in the Lithuanian unit. We use what has been globally created in the company (Big 4 (2)).

Notably, large audit companies (such as the Big 4) see BD as an increasingly essential part of their assurance practice (Alles and Gray, 2016). It is important to note that the size of the company determines the use of BD technologies not only due to prism of the size of the audit company itself, but also based on the size of the audit client. The business client's size was one the most prevalent factors mentioned by the experts who were surveyed. If business companies are small, their data are naturally not defined by the characteristics of 3Vs. This theoretical presumption is consistent with the answers from regulators and auditors:

Multinational companies are big drivers. Facebook and Google are driving the auditors' profession as well. We have to find ways to audit them and Big Data Analytics may help (Big 4 (1)).

The size of a company can have an influence on the use of BD from the point of view of the amount of data and probably in the future, even medium-sized companies will be able to apply and use it (Global financial services and IT company).

Resource-related factors. Audit companies have to be prepared in terms of their internal processes and capabilities in order to use BDA. They mainly need resources related to the preparation of information systems and integrated teams of employees for the successful application of BD and BDA. As IT competencies are becoming extremely important, audit companies currently resolve this issue by having an IT person in the company or outsourcing IT competence:

[…] We know what we want but we do not have IT competencies, so it's better to take from software companies. We are talking about major software companies like Microsoft, Oracle, SAP. Obviously, the cooperation with these companies will help to develop the tools (Big 4 (1)).

We have an IT person who works with different groups and consult about IT questions (Big 4 (4)).

Outcomes. *Audit process.* For audit companies, BD may help to provide a better understanding of the business client's environment. All the experts interviewed claimed that the application of these analytic tools made the audit process more effective, particularly during the phase of understanding the client's business environment and internal control, and during the phase of performing substantive procedures:

The reasons to perform an audit are more focused on risks, conduct it in a better, quality manner, adapt to progress (Big 4 (2)).

Effectiveness is at the first place as competition by prices is essential. We are working totally in electronic space (Big 4 (3)).

[…] our analytics show a certain tendency and variances in, for example, your [*business client*] company and you [*business client*] are able to analyse detailed data where and why it [*variances*] were found (International audit network).

An audit company, as a profit-seeking organisation, seeks to conduct an audit in the most efficient way from the client's and the quality point of view. Thus, analytic tools are one of the instruments that reduce the screening risk and thus minimise the likelihood of incorrect

conclusions. Essential attention in the BD-based audit is paid to the verification of data reliability. This is irrespective of whether the client's information would be received in the traditional way or via BDA; the issue of data reliability is always a priority:

The first work upon receipt of any information for auditing purposes is a test of its reliability. [...] The main question during the verification of quality control is whether a data reliability test has been made (Big 4 (4)).

A set of BDA tools may also be beneficial for the drawing up of audit reports. During the auditing process, co-operation is maintained with the company's management, and different reports may be drawn up (such as the auditor's conclusion, the auditor's report and letters to the management). The final auditor's conclusion is standardised, with clear criteria for the information provided. Therefore, the BDA may have an indirect effect through the type of the auditor's opinion. In other words, when applying more effective analytic tools, the assumption is that the auditor had a better perception of the client's environment, focused accordingly on the riskiest fields and decreased the likelihood of having provided an incorrect opinion.

However, the possibility of using analytic technologies in other audit reports is much greater and may create more added value for the client, only without the compulsory compliance function:

A letter to the management where we share observations on internal control systems, their shortcomings, provide recommendations that do not necessarily impede an audit, but we simply share our insights. Thus, here we see very great possibilities that namely in this place [*assessment of the internal control system*] the use of BDA would be of great help because […] it would be an analytics in different cross-sections (Big 4 (4)).

Quality. An audit market regulator and quality control may also be very important factors fostering BDA in external audits. State regulation of the audit market is gradually growing stronger across the world (SOX, Audit directives in the European Union, and so on). Thus, there is noticeable pressure from individual audit quality regulators to apply more advanced analytic tools in the audit process, which would translate into a better quality of risk-based audits.

The need to apply advanced analytics tools arose not only from the audit teams themselves but also from the quality control system. […] An American regulator treats quality control systems of audit companies extremely strictly and its audits are substantial. This is also the second strict-wise and attitude-wise regulator in the Netherlands (Big 4 (4)).

Institutional quality control factors of external audit companies via the audit market regulators in different markets produced a different effect:

Maybe, if we were only a national company and with this regulator, then we would probably have less boost, but in fact, our global methodology team is in America and they work in the strongest professional regulation environment. Thus, all approaches, all innovations, novelties and pressure on the maintenance of audit quality come from over there (Big 4 (4)).

This is an approach of the global body that regulates all this audit policy (Big 4 (1)).

Internal control. When public interest companies are audited, the use of these tools becomes an essential element for assessing the control system and managing the audit risk:

[...] one of our tools makes a very good report from the accountancy data, which makes it clear whether a person has made any entries he cannot make and whether the duties are separated, whether one and the same person does not do both, debit and credit, as this entails an additional risk (Big 4 (2)).

Thus, there is a need for tools that would enable conducting an audit in an effective way, that would enable to conduct it in a faster and better way, as quality may not be compromised either, and the audit standards themselves, as I have mentioned, become not looser, but more stringent (Big 4 (2)).

Estimation of a client's internal control system is one of the compulsory analytical procedures for an auditor. The more complex and global the client company is, the more multidimensional and complex is the internal control system of the client.

Issues related to the audit company. According to the research results, all second-order codes were disclosed in the case of an audit company, and this could be explained as all contingent factors influenced the use of BD and BDA, but the influence occurred at different levels and degrees of importance. Our research results suggest that the use of BD and BDA depends strongly on the audit corporate strategy and governance structure, and it confirms the research results of Verma and Bhattacharyya (2017). Moreover, it is likely that BDA enables auditors to act on structured and unstructured information. In line with Bhimani and Willcocks (2014), we claim that the traditionally presumed sequential and linear links among corporate strategy, governance structure and IS design are no longer in play. This is the reason that we also suggest that, when applying the BDA, additional attention should be paid to the company's IS as one of the elements of the internal control system. To a great extent, the IS depends on whether the auditor will be inclined to trust the data or to apply more detailed audit procedures. The issue of the reliability of the IS is crucial. Our study also suggests that the development of new analytical competence and even a new structure of audit teams with regard to BDA is necessary. In line with Al-Htaybat and Alhtaybat's (2017) views on BD in corporate reporting, building such teams (that include analytics) will require audit companies to determine whether they want to outsource their analytics, or whether they want to create their own platforms and systems.

4.2. Business clients

Current practises. *Experience* and *Increasing Trend*. The use of BD and DA tools in business companies (including international companies) is already the practice, with more than five years of history and a trend towards expanded use in the future:

Banking sector was especially in a very good situation concerning BD because of regulation to collect and save historical data. Analytics was just the next natural step forward (Financial institution operating worldwide).

The implementation of BD technology-based tools establishes the conditions for changing the thinking and attitudes of business companies:

BD is a global trend, everybody [business companies] can see and understand the value of using BD and this understanding has become comprehensible to owners of businesses (Financial institution operating worldwide).

Benefits. Business companies see BD and DA as an essential process in today's business environment, and use them for a different purposes and benefits in areas such as cost saving, planning processes, forecasting of the client's behaviour and sales:

[…] there are a lot of areas where labour work could be changed with analytic […] to predict the client behaviour is one the possible usage of BD and another could be after-sale service (Financial institution operating worldwide).

[…] each business unit has its own data analytics in different levels, such as risks, fraud, pricing, transaction analytics, accounting analytics, marketing analytics (Global financial services and IT company)

Financial resources. Business companies see the implementation and use of BDA as a process that is expensive and which requires financial investment. The influence of this concept is that it is mainly large companies that are able to integrate and use BDA widely.

[…] from practical point of view, there are a small number of companies in Lithuania, which could be able to use it [BDA]. It is understandable that you [Business Company] cannot expect results from BD in six months, it is quite a long period and company has to understand this, you have to invest and work (Financial institution operating worldwide).

Institutional factors. *Regulation system*. The sector regulator (such as the financial sector) and the audit regulator play an important roles in the use of BDA:

[...] financial institutions historically must accumulate and save a different kind of data to manage risk issues (Financial institution operating worldwide).

The audit regulator should encourage audit companies to be more advanced technologically, to provide fresh news about novel audit analytics. Such topics are not even included in annual training for auditors (National audit network company).

Market structure. The main motivating factors for using BD in business companies are strong competition and long-term relationships with customers. Many interviewees emphasised:

The main motivating factor is to create a sustainable relationship with customers (Financial institution operating worldwide).

Competition is very strong in the market and a company needs to be better than its competitors, so BD helps to ensure this aspect (Global financial services and IT company).

Education. These global trends influence the need for employees with broader interdisciplinary competence, including knowledge about business, information technology and mathematics. Business companies confirmed the importance and lack of competent employees globally:

[…] companies are lacking competent employees and looking for them, … it is very difficult to find employees who would be ready to work in BDA area and even with experience (Financial institution operating worldwide).

[..] there is an increasing level of interest from universities and study programmes but we still are not able to find a fully prepared specialist able to work with BD. Mostly cases we invest in competences improvement of those employees who have IT, mathematical or analytical skills (Global financial services and IT company).

Company factors. *Strategy-related factors.* From the client's perspective, the use of BDA and DA rely heavily on the corporate strategy and top management's support.

The main objective of all financial institutions operating worldwide group is BD integration into business processes with purposes to minimise costs and to discover new possibilities for business development (Financial institution operating worldwide).

[...] as changes are very fast in the market, decisions made have to be grounded by BD and according to strategic choice of all company groups in all Europe and this is not limited to the Lithuanian market (Global financial services and IT company).

Resource-related factors. Large companies will be more financially able to invest in new technologies and capabilities (infrastructure and competent employees), as well as to invest in the future value that could be created by BD. In addition, it could be stated that companies in developing countries might be able to integrate BDA more quickly:

[...] because banking companies already started to develop business with more recent information technologies and systems that allow to integrate BDA and to be more flexible (Financial institution operating worldwide).

The main challenges for the application of BD in external auditing are the quality and comparability of data, and qualified BD analysts because companies need to have employees who can find patterns in data and translate them into useful business information:

BD quality is very important … […] We have two groups of BD, first is more raw data and using it is allowed but risks need to be evaluated, second is fully prepared BD (Financial institution operating worldwide).

The main internal challenge of using BD is HR and analytical skills integrating IT and business skills. […] Also, one more challenge is IT system and necessary investments into these systems, consultancies (Financial institution operating worldwide).

Outcomes. *Internal control*. Business companies understand BD as the possible or the main source of data to manage the business and use BDA tools for internal management, decision making, planning and reporting purposes:

We use BD in weekly control process by evaluating changes, influences and making decisions. […] Our expectations are that BD application will grow in the area of business process development in the future. (Global financial services and IT company).

Issues related to business clients. The research results showed that not all second-order codes were indicated in the case of business companies. In particular, the difference from audit companies was in the area of Outcomes. This could be explained by the fact that business companies mainly use BD information for internal purposes to manage business processes and make decisions. The research results confirmed that the possibility of applying BD and BDA depended on the size of the business company and its strategic orientation. Public interest companies, companies with international headquarters in different countries, may encounter actual BD in their activities. The motivation to use BDA and other DA is also important regardless of whether the client is a state-owned company or a private company. The main motivation to use BD and BDA tools is related to strong competition.

4.3. Regulator

Current practises. *Increasing trend*. Regulatory bodies understand the importance of BD / BDA tools and see them as an increasing trend for all sectors, business companies, audit companies and as a future direction in the case of regulatory bodies as these still do not have experience in this area:

[…] our performance is very closely related with BD technologies. […] because of looking at the future all large business companies will need to provide all information to regulating governmental institutions in electronic form starting from 2017 (Tax analytics).

Benefits. Regulatory bodies confirmed the usefulness of BD and BDA for large business companies, governmental organisations and at the state level from the perspectives of time and quality:

It [analytics tool] shows directions where mistakes, irregularities might be (Tax analytics).

[…] this was the initiative from business companies. As The State Tax Inspectorate disrupted companies with questions about different kind of data for two weeks, so it [BDA] is a benefit for both parts (State Tax Inspectorate).

Financial resources. According to the experts interviewed, there is a need for e-audits and for a funding project to support the implementation of e-audits, which will help to develop and use BD-based analytic tools for different purposes:

There should be some actions taken and start a project implementation in a three-year period (State Tax Inspectorate).

Cost benefit aspect is very important and we calculate the employees' time saved for different processes from regulator and business company sides, this helps to evaluate money saved in five years, ten years or fifteen years (Tax analytics).

Institutional factors. *Regulation system*. Regulatory bodies play an important role at various levels, such as in the tax environment, and in terms of sector regulation and audit regulation. In the global regulation practice, it is still possible to notice different variants, ranging from the compulsory universal certification of accounting systems to plans to certify accounting information provided by companies:

Accounting systems are certified at the state level. [...] the same way an accountant must have a certificate, an IS must be certified. [...] The future will unambiguously have to be this way, as the number of errors due to low-quality information will make the process very painful (State Tax Inspectorate).

According to the experts interviewed, one of the factors motivating the use of BDA will definitely be the fostering of e-audits at the state level:

It is very important to make a breakthrough in the analytics, an audit breakthrough, a quality leap so that we could audit banks not in the way we audited Snoras or Ūkio bank. *Positive audit reports were issued and in a half-year, these banks became insolvent* (explanation added) (State Tax Inspectorate).

Education. Regulatory bodies indicated the future need to integrate educational institutions in this increasing trend towards BD and BDA.

We plan to integrate researchers in the development of analytical tools. […] there is still a lack of knowledge and wisdom about the same understanding. Education would be able to play a key role in this process (State Tax Inspectorate).

Outcomes. *Audit process.* Obviously, audit regulatory bodies do not participate directly in the audit process, but their key function is the public monitoring of quality control. Responsible regulatory bodies evaluate how audit evidence is documented, as well as the compliance with ISA and the completeness of substantial audit procedures and control tests, including audit evidence gathered via BD:

If transactions and accounting records are maintained in a decentralised way, a large company may simply face the fact that data are wrong. Overall, the system seems to be correct, but decentralisation may show that, with time, these data have changed. This may be a big surprise for such large companies (Regulator (2)).

Quality. As Lithuania abandoned national auditing standards in 2009, the Lithuanian audit regulator does not have sufficient authority to change the implementation of the standards. It is not the standard setter and has more of an advisory role:

So, the biggest driver comes from international accounting settlers. […] For the more advanced regulators in Europe and other territories it is the tendency. As auditors, we move to a more sophisticated IT environment of auditing the clients. The regulators have to understand how the auditors audit. It might be even the beginning of the process (Big 4 (1)).

Internal control. Essentially, ISA lays down the provisions for assessing the client's internal control system, the IS and controls regarding the IS:

There are many different types of accounting software and auditors are familiar with some and not familiar with others (Tax analytics).

The possibility of checking data in real time results in the likelihood that an audit may create a higher value for the client. This would not only be an auditing process based on historical data:

The reaction to on-going processes and the speed are very important. Now auditors make a sampling and audit the data that is half-a-year, one-year old. […] Thus, this reaction in current time and controlling such data is very important to be able to react in a fast and expeditious manner (Tax analytics).

Overall, auditors and regulators presented a conservative attitude towards incorporating BD in decision making for auditing aims. They admitted that BD played an important role, but that the change will still be taking place in the future.

Regulator-related issues. The research results showed that second-order codes were disclosed differently in the case of regulators. Company-related factors were not disclosed because regulatory bodies are not treated in the same way as are companies. Regulatory bodies still do not have current practice in the use of BD and BDA tools, and the implementation thereof is planned for the future. Institutional factors were disclosed because regulatory bodies play an important role at various levels, such as in the tax environment, in sector regulation and audit public oversight. Outcomes were mainly disclosed with regard to quality, and this could be explained by the fact that regulatory bodies are responsible for the public oversight of quality control, continuous learning and education about innovative audit techniques, including BD and BDA. According to the research results, regulatory bodies could be seen as followers of business and audit companies in the use of BD and BDA tools.

5. Discussion and conclusion

5.1. Comparison and discussion of the results

Based on the qualitative research, we identified four key results. By disclosing a comprehensive view of current practices (1), we identified two groups of motivating factors (company related (2) and institutional (3)) for the use of BDA from an external auditing point of view, which may lead to the desired outcomes (4) for the audit companies.

Our findings showed that current practise differed for business companies, audit companies and regulators. Business companies had used BDA tools for more than five years and saw this as an increasing trend in the future because of strong competition, and these tools were used to understand the customers' behaviour, to manage risk and for internal management purposes. Hence, the use of BD and BDA was focused mainly on the internal

management needs and market/sales expectations. Audit companies had approximately three years of experience in the use of BDA tools. The use of modern analytics in large network audit companies was usually based on the global strategy of IT innovations and with the main purpose of ensuring the quality of the audit process and to issue a relevant auditor's report. Regulatory bodies still did not have experience in the use of BD and BDA tools, and assume this would be an increasing trend in the future.

Our study therefore emphasises the importance of interdependence among audit companies, business clients and regulators to enable the use of BD and BDA. Given this, business companies might be the drivers of the use of BD and BDA tools, and audit companies might adopt these innovations because of high competition in the audit market. Moreover, the current practices of business companies provided and even created suitable conditions for external audit companies to use all the data (financial and non-financial, structured and unstructured) for audit purposes. This motivates external audit companies to use BDA as, firstly, business companies are able to provide BD and, secondly, the use of BDA for audit purposes allows the achievement of the desired outcomes, such as the efficiency and effectiveness of the audit, higher audit quality and minimising audit risk, as well as having a better understanding of the client's business environment and internal control.

Specifically, the study has provided evidence of the importance of motivating factors and circumstances that influence the use of BDA in external auditing process (Table 5).

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Table 5

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The results from the interviews showed that contingent factors may act both on the company level (such as size, strategic orientation, structure and technology) and on the institutional/external level (the audit market environment). What is more important is that the influence of different contingent factors was not the same. Company-related factors had a direct influence on the use of BDA in different phases of the audit, depending primarily on the audit company's data-driven strategy and the business client's size. Moreover, the audit market environment (the national regulator's policy or the competition level) could be assumed to be an indirect contingency factor because audit companies have to evaluate environmental uncertainty and adapt to it.

Our findings showed that a company factor such as size influenced the use of BDA for both audit companies and clients. These results are in contrast to the study by Li *et al*. (2018), who found that corporate size did not influence the adoption of audit analytics in internal auditing significantly. One reason could be that, if the audit client is extremely large, the client will be confronted with plenty of semi-structured and unstructured massive data that cannot be analysed using traditional audit software and analytics. On the other hand, only a large audit company may have sufficient resources and substantial tools to be able to audit such a company. This is also consistent with previous research stating that large companies have extensive specialisation, standardisation and formalisation (Wickramasinghe and Alawattage, 2007), while small companies will not be able to provide all the necessary information as BD. In addition, a small audit company would encounter challenges when attempting to use BDA because of lack of professional staff and technological capability (Alles, 2015).

With regard to the strategic orientation, our results are consistent with those of Li *et al.* (2018) and Verma and Bhattacharyya (2017)'s findings that the major reason for the non-

adoption of BDA was that companies did not realise the strategic value of BDA, and they were not ready to make changes due to technological, organisational and environmental difficulties. Therefore, we conclude that a company's strategic orientation and structure may also be important influential factors concerning the use of BDA. On the other hand, competent employees, internal capabilities and IS are resource-related audit company factors because they are derived from the size of the company and from the strategic orientation/attitude towards the adoption of technology. Moreover, audit companies attempt to find a trade-off between the extent of information demanded by the environment and the company's available resources.

Audit market regulations and education may have a particular impact on an audit company's decision regarding the design of an audit strategy, such as how to apply modern auditing tools, how to ensure audit quality and what the topics for auditors' training should be. Our results are in line with Tarek *et al*. (2017) and Li *et al*. (2018), confirming that the attitudes of audit regulatory bodies and legislative regulation followed by sector regulation and market structure are critical for fostering the use of BDA.

Specifically, we provide the following theoretical and practical implications:

- Our paper expands on Li *et al.*'s (2018) study on understanding the use of audit analytics for internal auditors due to several reasons. We aimed to investigate practices pertaining to the use of Big Data Analytics in particular (not all audit analytics in general) in external auditing. Although external and internal auditors have similarities in terms of carrying out audit procedures, the role of external auditors of decreasing information asymmetry for capital markets is distinct and unique when compared to internal auditors. Furthermore, external auditors must be independent and do not participate in an audited company's activity constantly, as internal auditors do. This means that external auditors have to gain understanding of the client's environment and performance in a very short time; hence, BDA might be a useful tool. While Li *et al*. (2018) emphasised that only internal auditors should have more demand for the use of audit analytics in order to be efficient and effective, the high prices and competition in the external audit market are very important factors motivating the need to be more effective and implementing more analytics. From the interviews, we may summarise that audit clients seek: a) to negotiate for better pricing because of high competition in the audit market, and b) to get more value and insights about corporate risks and performance. This leads to a trend whereby external auditors are likely to focus on the procedures not just to satisfy regulatory requirements, but to provide more value for the audit client; hence, BDA may be one of the solutions.
- The results of our research also indicated diverse motivation in the use of BDA depending on the business client's size. Large business companies usually acted as innovators in applying BD, and audit companies were followers. In the case of the client being a small business company, audit companies played a proactive role and even had to demonstrate the value of using BDA in the audit process.
- The result that the national audit regulator was lagging behind in implementing audit analytics was particularly problematic from a BD and BDA perspective. In most cases, the national audit regulator played more of an advisory role, and was currently lagging behind with regard to BD and BDA. From this perspective, the study also outlined the dilemma of quality. Audit regulators need to ensure public monitoring of quality control and provide training for auditors. However, regulators lacked knowledge about innovative BD-based techniques.

5.2. Conclusion and further research directions

The results of our research revealed audit companies' intentions to use BDA and to expand their understanding of the use of BD and BDA tools in external audits by emphasising the close relationship of audit companies and different, yet related groups such as business clients and regulatory bodies.

We wish to emphasise the need to implement BD and BDA-based audit practices for audit companies as a way to improve audit quality and to foster the efficiency of audits, which may result in a competitive audit fee. This research also offers insights into helping to customise their audit strategies.

In addition our research results indicated that large business clients were the main drivers of the use of BD and BDA in external auditing, as the current practices of large business companies allow and create suitable conditions for audit companies to use Big Data (financial and non-financial, structured and unstructured) for audit purposes. Large business clients usually act as innovators in applying BD and BDA, while audit companies are followers. However, a different direction in this relationship could be indicated in the case of small business clients, as audit companies play a proactive role in this scenario and even have to show the additional value of using BDA. Moreover, based on the interviews, we suggest that large networking audit companies may gain long-term effectivity, which is important regardless of whether the client is new or established. The other outcome is to ensure a higher audit quality resulting in better value for the shareholders, the management and society.

For business clients and regulators, this study might help them to understand the advantages and challenges of institutional and company factors concerning BDA use.

Contribution

Our study aims to contribute to the literature on auditing in the following ways. Firstly, it adds to the small body of research by offering an empirical investigation the state-of-the-art of BDA usage and motivating factors in external auditing. While prior studies (for example, Li *et al*., 2018) have focused on internal auditing, this paper addresses BDA and external auditors in particular. In addition, Verma and Bhattacharyya (2017) found that complexity and perceived costs were the inhibitors that prevented the adoption of BDA in business companies, while our research results indicated that the factors mentioned above were not critical. Secondly, our study examines the phenomenon of Big Data and BDA in the context of auditing. It is important to note that BD has specific characteristics compared to other types of data, and opportunities to use BD within BDA is of increasing importance for audit companies, which to the authors' knowledge, is absolutely new. Structured (around 10 per cent) and unstructured (around 90 per cent) of data that are large in size cannot be analysed using traditional software and database systems (Al-Htaybat and Alberti-Alhtaybat, 2017). Thirdly, the paper presents a contingency-based theoretical framework as a model explaining how different motivating factors may influence the use of BDA. The research also makes a methodological contribution by using the approach of constructivist grounded theory for the analysis of qualitative data.

Limitations

The conclusions of this study are based on interview data collected from 21 participants. Future studies may investigate the issues addressed in this study further by using different research sites and a broader range of data. Although the theoretical method is highly transparent, it requires further testing to verify the mechanism on which it is based.

Furthermore, by keeping BDA as a tool, the use of which depends on the size of the company, our interviewees were all employed by particularly large companies. There is a limited number of large companies in Lithuania that are open to co-operation. To test our research question more broadly, we suggest including additional audit and business companies in future research.

Future research

There are a number of future research opportunities, as this is still a novel research area in the field of auditing and accounting. Having chosen a qualitative approach forgoes a broader data collection method, which may provide different views. It would be worthwhile to carry out further empirical analyses of BDA currently or potentially in use through a detailed case study or a quantitative survey to gather a broader range of insights. Our interview results provided mixed results with regard to the need to change auditing standards and auditing procedures when using BD. Thus, a deeper discussion of possible changes to audit procedures could be another relevant area for future research. As we identified that the national audit regulator is currently lagging behind in the area of audit analytics, it would be relevant to investigate the quality dilemma from the perspective of public monitoring of quality control, and the impact of international and national audit regulators on BDA and audit analytics in general. Furthermore, it is worth conducting research on changes in external auditors' profession through education in analytical interdisciplinary skills. At the same time, future research could expand the scope of BD and BDA research for the internal purposes of companies, such as internal auditing, control processes and performance measurement. The interviewed experts confirmed the importance of BD usage for the management of pricing, fraud detection, complaints and risk assessment. Performance measurement integrated with BD would be able to support planning, control and decision-making processes by providing meaningful and appropriate information.

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