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The digital transformation of external audit and its impact on corporate governance

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ABSTRACT

The literature demonstrates the growing interest of digitalization in organizations. The purpose of this paper is to study the influence of digitalization on audit's business and to understand how it can improve the role of audit as a governance mechanism. A qualitative approach was conducted by interviewing auditors from the five largest auditing firms in France. This paper demonstrates that digital technology is impacting at five key levels audit firms especially the audit role as a governance mechanism. Digitalization will improve the audit relevance (1) allowing audit firms to extend their offers by proposing new services (2). It will also improve the audit quality mainly by analysing all data's customer (3). Finally, with the digitalization a new auditor profile emerges (4), enabling the culture of innovation within audit firms (5). Thus, the firm governance will be improved but the managers 'discretionary power will be limited. This research highlights the importance of implementing digital strategies to provide regulators with the necessary modifications that need to occur for audit standards. It should enable Business School and universities to adapt their training programs according to the audit firms' expectations.

1. Introduction

The literature on governance generally perceives the audit as a governance mechanism to avoid potential conflicts between shareholders and managers and to ensure the disclosure of reliable accounting information (Carcello et al., 2011). However, the quality of the audit must be ensured. Indeed, the financial scandals of the beginning of this decade such as Enron or Tyco (Yang et al., 2017), disseminated the doubt regarding the audit' relevance and quality. Despite the new law on economic regulation (Sarbanes-Oxley act of 2002 in USA) which strengthened auditors' controls, particularly through the PCAOB[1] and the audit committees, audit quality remains the main concern of the stakeholders (Beisland et al., 2015; Hope et al., 2008; Francis and Wang, 2008). As a result, the audit must evolve for three basic reasons. First, because it is intended mainly by shareholders, that consider the audit as a service providing them with reasonable insurance. In fact, past results should reflect a faithful image of the firm and comply with regulatory requirements. Second, because the audit report prepared several months later the end of the fiscal year, is based on historical data. It does not bring any forward-looking elements. Finally, because the audit report is standardized, thus it does not meet the specific needs of its actual or potential users, to help future decision making. So, managers perceive audit as a cost and not necessary as an added value because reports most of the time don't provide them with recommendations for identified issues on historical data. Digitalization has significantly impacted the labor market (Dengler and Matthes, 2018) and changed the way of doing business in all areas of activity including audit firms. A consensus regarding its impact on organization and on employees' activities can be identified (Dumitru, 2016). According to Meier (2017) "*Today, a fourth generation of even more innovative tools is shaking up our habits*". In order to stay competitive and stand out from other companies, audit firms must evolve their business model (Sahut et al., 2013) and service offer by acquiring innovative technology to propose digital solutions (Van Den Broek and Van Veenstra, 2018). Therefore, digitalization should change the way auditors will handle audit activities by providing additional

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[1] https://pcaobus.org/standards.

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insights to answer customer's needs.

According to Nambisan et al. (2017), digital management is based on the implementation, for example, of processes, tools, usages… managed all together. The advent of big data and social media changes the way companies can access to information with the availability of new Key Performance Indicators (Arnaboldi et al., 2017) to improve firm competitiveness (Van Den Broek and Van Veenstra, 2018). Therefore, audit activities are at a crossroad; firms must modify their approach as digitalization change the way audits are performed. Thus, they must integrate digital technologies in their future strategies. Based on Alain Pons,[2] president of Deloitte France "*It is time to move from a pricing debate to a higher added-value service. By providing insurance on security, auditing is different from account additions*". Digitalization highlights the ever-changing needs of audit functions to provide a deeper and robust analysis to their clients. Nevertheless, the audit activity is a regulated and standardized service, and digitization must consider these constraints.

Several researchers have tried to understand the effects of new digital technologies (Essentially Big Data and Artificial Intelligence) on companies in terms of data analysis (Warren et al., 2015) and external reporting (Al-Htaybat and Von Alberti Alhtaybat, 2017). However, research on audit firms is still limited (Issa et al., 2016). Some have studied the impact of digital on audit firms 'performance or risk analysis (Krahel and Titera, 2015; Cao et al., 2015). Others have examined the impact of these technologies on the quality of the auditor's judgments (Brown-Liburd et al., 2015). Vasarhelyi et al. (2015) have identified for example that the adoption of digitalization and analytics is increasing for the internal audit environment when audit firms (external audit) have not moved at the same pace. Gepp et al. (2018) argue that big data analysis is not yet widespread and that more studies need to identify the opportunity of using such technology. As highlighted by Appelbaum et al. (2018) there are a few researches analysing the influence of digital on the transformation of audit firms and audit process. In this context, the aim of this paper is to study the impact of digitalization within audit firms. How it can improve the role of audit as a governance mechanism and limit the discretionary power of managers?

This research focuses only on big data technologies and the digitization of the internal processes of audit firms (including the audit process). Indeed, these technologies are currently the most used by audit firms in their digital transformation. Also, other technologies like blockchain can have a different impact on the audit business. This research has a double interest. On the theoretical side, it can enrich the literature on governance and audit quality by explaining how external audit must evolve digitalization and the development/integration of new digital tools (big data, analytics, artificial intelligence, etc.) and how this evolution will allow the audit to perform as a mechanism of governance. On the managerial level, this research should help audit professionals to better understand digital transformation strategies and the evolution of audit practices. It could also help the regulators to identify the necessary modifications of audit standards. In addition, it should enable Business School and universities to evolve their training programs according to the new needs of audit firms. Indeed, in this evolving environment, auditors need to complete their professional knowledge and auditing practices by developing other ways of thinking, analysing information or acquiring some IT skills.

The article is structured as follows. First, we present the theoretical framework and the methodology of our research. Then, we present and discuss the main results induced while emphasizing its main contributions and limitations.

[2] https://www2.deloitte.com/lu/en/pages/audit/solutions/deloitte-audit-services.html.

2. Theoretical framework and literature review

The audit demand, as a governance mechanism, can be explained by the agency theory, but also by the stakeholders' theory. With the digitization of audit firms, audit is evolving into a new role incorporating new areas of insurance. This digitization should also improve the quality of the audit.

2.1. The agency and stakeholder's theories and audit

Several theories can explain the demand for audit services in relation to corporate governance. Agency and stakeholder's theories remain the most widely used theories in the literature in this area (Brennan and Solomon, 2008) explaining the need for audit services. Indeed, external audit can reduce the risk of earning management by managers and consequently improve the quality of the accounting information communicated to the stakeholders.

Theoretically, audit is seen as a solution to the agency problem between managers within companies and their shareholders (Beisland et al., 2015; Hope et al., 2008). Managers are responsible for the production and disclosure of accounting information and should be aware of everything that goes on in business. Shareholders are however far from the company and only have access to the information communicated by the managers. As the shareholders do not necessarily have a blind trust in the managers 'practices, an agency conflict can arise from this information asymmetry between these two parts. Indeed, managers are in a privileged position that gives them a certain power and a desire, sometimes, to satisfy their own interests neglecting the shareholder interests. In this context, the principals (stakeholders) control the activities of the agent (managers) to limit agency's cost (Jensen and Meckling, 1976). External audit reduces the risk of publication of false information to shareholders and allows them to take accurate decisions based on reliable information (Watts and Zimmerman, 1986). Thus, the main role of audit is to increase the credibility of the published accounting information. The auditors, mandated by the shareholders, control the financial statements, the managers 'compensation and all the contracts concluded by managers. By providing an independent opinion to the shareholders on the reliability of the accounting information produced by the managers, the audit can promote a better governance of the company by reducing the information asymmetry between these two parties as well as the discretionary powers of the managers (Jensen and Meckling, 1976; DeFond and Zhang, 2014; Beisland et al., 2015).

Nevertheless, by considering only the shareholder-manager relationship, the agency theory limits the role of managers to the satisfaction of the shareholders. However, managers must satisfy several stakeholders such as suppliers, customers, employees, banks, citizens, etc. In this context, the stakeholder's theory proposed by Freeman (1984) extends the field of agency theory by considering all stakeholders. According to this theory, the company is no longer perceived as a closed world where only shareholders are considered, but as an organisation that builds relationships with all stakeholders within its environment. Freeman (1984), defines stakeholders as "any group or individual who can affect or is affected by the achievement of the organization's objectives" (p. 46). All stakeholders use accounting information to take their own decisions. In this case, the role of the auditor is not limited to reassure shareholders about the reliability and fairness of the accounting information disclosed by the managers, but also to extend it to all stakeholders. Therefore, the auditor is no longer the agent of the sole managers, but also the agent of all stakeholders paid by the audited entity and not by the shareholders. Audit must evolve from a mission focused mainly on shareholders' needs to an audit centred on meet other stakeholders's expectations.

2.2. Digitalization of audit firms: towards a new audit role

Traditionally, auditing has three roles as a governance mechanism: monitoring, information and insurance roles (Wallace, 2004). (1) The monitoring role consists of reduce agency costs by controlling the quality of the accounting information produced by managers (agents) and by limiting their discretionary powers. (2) Through the information role, the auditor should verify the reliability and fairness of the accounting information that is the basis for any decision making by shareholders and other stakeholders. (3) Finally, the role of insurance does not address the problem of information asymmetry between shareholders and managers, but risks that can be transferred by managers to other entities to hide the financial situation of the company. In this case, the role of the auditor is to reassure investors that these risks do not exist. To reach their goals, audit firms can use new digital technologies to automate data processing and limit human intervention. Information systems (including accounting system) will be increasingly integrated, locked and secured. This will reduce the problems of information asymmetry between managers and stakeholders and risk transfers. Thus, the audit demand, related to these three traditional roles, will no longer have the same magnitude and would be impacted by technological developments. Several authors state that a new audit role, with regards to the role of assurance, is emerging (Wallace, 2004; Jeacle, 2014, 2017; Andon et al., 2014). According to these authors, the audit can extend to other areas of assurance in various domains where investors and other stakeholders need to be reassured, such as, performance measures, reliability of information systems, e-commerce, cyber security, social and environmental responsibilities, etc. However, some authors consider that the extension of the audit to other fields depends on the legitimacy that audit firms can have to ensure audits in these new areas. This will depend on the profession's ability to evolve audit practices and programs (Andon et al., 2014) and on its ability to master new technologies, to evolve their audit offer and build their legitimacy in these new areas.

2.3. Audit firm digitalization and the improvement of audit quality

The financial scandals appeared in the early 2000s (Enron, WorldCom, Parmalat…) testifies to manipulations done by several managers and showed the limits of this governance mechanism. An improvement of audit quality is therefore necessary to enable the audit to play its full role as a governance mechanism (John and Jahera, 1988). DeAngelo (1981) defines the quality of the audit as the probability for an auditor to detect discrepancies in the financial statements and disclose them to the parties concerned. An upper audit quality improves the quality of financial information and promotes a better control by managers and better decision-making by investors. Several previous studies have demonstrated the increased demand for quality audit to reduce information asymmetry as well as earning management. For example, Francis et al. (1999) demonstrated that earning management is negatively related to the audit quality. In addition, other studies find that investors, especially international ones, require superior audit quality and enhanced governance to invest in companies (Ashbaugh and Warfield, 2003; Leuz and al., 2009). Other studies have also demonstrated the indirect and positive effects of audit quality, used as a mediating variable, on other governance mechanisms (Abbott et al., 2003).

Nowadays, audit firms are digitizing, developing their internal processes and studying how to exploit big data and new digital tools to add value to their customer. This digitalization may improve the audit quality and better satisfy shareholders and other stakeholders by making the audit more relevant. First, with digital tools such as the analysis of big data, the auditor can evaluate all data of the audited firm and no longer use the sampling method. Indeed, digitalization of audit processes enable him to improve risks assessment and the quality of judgments by identifying all the anomalies and by proposing solutions to issues highlighted. Finally, the audit could also focus on current data, and not just historical information, to give a prospective vision of the sustainability of audited firm by evaluating the current level of sales, the planned order booking, etc. This additional analysis could significantly reduce the managers' opportunistic behaviours and thus enhance the audit relevance and improve the corporate governance.

2.4. The influence of digitalization on audit firms

According to Porter and Heppelmann (2014), competition and the increasing pressure to provide their clients with relevant and reliable information are the main factors driving audit firms to digitalize their processes. In order to stay competitive, audit firms must evolve their business model and service offer by acquiring innovative technologies to propose digital solutions (Van Den Broek and Van Veenstra, 2018). Within the next 5 years, 58% of auditors and businesses consider that new technologies will directly impact audit functions (Macaulay, 2016).[3] In order to develop their audit processes, several audit firms have invested in new artificial intelligence (AI) tools such as KPMG (IBM's Watson), PricewaterhouseCooper (Halo) and Deloitte (Argus) (Kokina and Davenport, 2017). According to Krahel and Titera (2015), by moving from the paper-age to digital management of the information, digitalization is impacting the way audits are conducted.

Among digital technologies, big data and AI are currently the most used by audit firms to evolve their processes and service offerings (Montes and Goertzel, 2018). For Gartner,[4] big data can be defined by the 3V's (Velocity, Volume and Variety). Wamba et al. (2015) recommend adding Value and Veracity moving from three to 5V's. Thus, big data can allow auditors to quickly have access (Velocity) to all information (Volume). They sometimes need to structure the data that could come from different sources (Variety), control content (Veracity) and finally make sure that information collected will have an added-value (Value).

The audit literature focused on studying big data and AI (Kichin, 2014; Zhang et al., 2015; McKee and Lensberg, 2002; Pendharkar, 2005; Raphael, 2017). However the number of papers in this area remains limited. By analysing 301 papers, centred on analytical procedures, Appelbaum et al. (2018) found, for example, that within the audit techniques, only 7% of the papers cover the data analytic topic. Several researchers studied cognitive technologies (big data and AI) and their impact on the internal behaviours of companies in terms of data analysis (Warren et al., 2015), corporate reporting (Al-Htaybat and Von Alberti-Alhtaybat, 2017), audit performance and risks analysis (Krahel and Titera 2015; Cao et al., 2015; Issa et al., 2016). Montes and Goertzel (2018) state that cognitive technologies modify the way companies deal with information management by increasing the understanding of risks or weaknesses.

Some researchers tried to understand the effects of big data on the best way to conduct audit in the future. Kim et al (2016) determine that specific tools can be used for the analysis of big data collected by classifying, identifying and eliminating redundant data in a secure way. According to Zhang et al. (2015), big data analysis will allow auditors to deal with data gaps such as Consistency (format, synchronization and contradiction), Integrity (incomplete or data modification), Identification (data structure), Aggregation and Confidentiality (Griffin and Wright, 2015). Krahel and Titera (2015) claim that auditors can save time and focus on the analysis rather than on data collection managed by the technology. Moreover, some researchers suggest that big data analysis influences the auditors' behaviours regarding their judgments and decision making (Brown-Liburd et al., 2015) and support them in

[3] https://www.forbes.com/sites/kpmg/2016/11/23/how-technology-is-transforming-the-audit– M.T.Macaulay (KPMG)- How technology is transforming the audit.

[4] www.gartner.com/it-glossary/big-data/.

the automatic data correction (Kogan et al., 2014). Nevertheless, according to Yoon et al. (2015), big data should be considered as a complement of the "traditional audit evidence".

Some researches are interested in the impact of data analytics on audit firm's capacity to detect frauds (Nigrini, 2018; Richins et al., 2017). Indeed, one of the main goals of the digitalization of audit firms is to detect frauds and to be able to better understand and quantify the risk for their clients (Brown-Liburd et al., 2015). Researchers conclude that data analytics could highlight frauds by detecting rounded number often used by fraudsters (Nigrini, 2018), but some ones such as Richins et al. (2017) recommend using both techniques (manual fraud-detection combined with automatic fraud-detection) to avoid this kind of issue. According to these authors detect the fraud, secure information and provide clients with relevant reporting are key for trust.

Finally, some researches on cognitive technologies found that using cognitive technologies provide clients with a better quality of data analysis and a more accurate identification of potential issues (Cao et al. 2015). In this context, McKee and Lensberg (2002) and Pendharkar (2005) consider that AI techniques could help auditors to predict bankruptcy, while Sajady et al. (2008) argue that it improves the quality of financial analysis. Indeed, with the advent of big data and AI, the main challenge will be the interpretation of results. In addition, according to Krahel and Titera (2015), audit using digitalization, can be considered by both auditors and companies audited as less intrusive and the analysis of big data can improve the relevance of auditor's functions for data collection and reconciliation. In the same line of thought, Lombardi et al. (2014, 2015) conclude that digitalizing is changing the audit landscape and will revolutionize the way audits are performed. Moreover, Dinesh and Juvanna (2017) stress that companies must consider cybersecurity's risks using software to ensure corporate safety and privacy, and to minimize risks.

3. Methodology

To study the perception of major audit firms regarding the effect of digitalization on their business, a qualitative study was conducted with the five largest audit firms in France (Big Four and Mazars). Auditors were interviewed, following the principle of data saturation, reached in the 15th interview. Thereafter, interviews were conducted with 3 partners to validate the results. In total, 18 semi-structured interviews have been recorded, totally transcribed and analysed.

3.1. Sample presentation

A group of experienced auditors (with at least the rank of manager) from the largest audit firms in France, has been selected, all involved in new data analysis technologies or with this competency mentioned on their CVs. By relying on social networks and especially LinkedIn, research was done using keywords in relation with digitalization and new data analysis' technologies (analytics, data transformation, data visualization, machine learning, process digitization, IT, etc.). A list of around 100 auditors, operating in different sectors of activities, was collected and auditors were contacted via social networks and by email. After several reminders, 18 auditors have accepted to be interviewed; 7 interviews were conducted remotely by Skype or through phone calls and 11 interviews face to face at auditor's work place. All respondents, with high educated profiles, studied in business schools (65%) or universities (35%). They have different positions within their firm from Manager to Partner. Among these interviewers, 3 have an innovation coordinators responsibility in their firms (Table 1). Within the sample, auditors have an average experience of fourteen years, with an average age of thirty-six years old. Most of the respondents are in Paris Area against 25% from other French regions. The respondents are mainly male (72%). The interviews' duration was between fifty-five and seventy-five minutes. For confidentiality reasons, and as requested by the interviewees, information such as names and ages are been removed.

3.2. Interview guide and data analysis

Auditors were interviewed, using same interview guide, organized around five themes: (1) the place of digital in audit firms (definition, opportunities and threats, impact on audit firms culture and on their internal information system), (2) Digitalization and transformation of the auditor's profession (impact of digitalization and data analytic on audit profession, impact on data security, internal implementation strategy, advantages and constraints of the digitalization of their customers), (3) Strategy of audit firm to adopt digital technologies (what strategy to adopt to become an expert on digital?, strategy of differentiation, customers support strategy), (4) Digital strategy about the recruitment and the training (impact on recruitment and training policies). (5) Finally, auditors were asked about the impact of technological developments in the audit process on corporate governance: Will the audit better play its role as a governance mechanism? Moreover, how will the audit of tomorrow improve the quality of accounting information and stakeholders' decision-making? The analysis method is based on the second-generation grounded theory's foundations (Strauss and Corbin, 2008). Grounded theory was selected for this empirical study because it provides a methodological framework able to emerge concepts have not yet been developed. The transcripts of interviews were content-analyzed by the technique of coding, which divided relevant content of transcripts into categories of different themes (Krippendorff, 2004). Two coauthors coded the transcripts following Miles and Huberman (1994) and Gillham's (2000) methods of qualitative data presentation. Then, the results of each respondent were analysed and compared one to the others. To validate our analysis, the results found were presented to three partners. This step allows us to insure the internal validity of the results.

4. Results

Findings confirmed that digitization will allow the audit firms (1) to rethink and optimize their audit process, (2) to encourage the emergence of new auditing offers, (3) to improve audit quality and finally (4) to redefine the future auditor's profile and embody a new culture of innovation (Sahut and Peris-Ortiz, 2014). All these implications will improve the company's governance mainly by reducing the discretionary power of managers and by enhancing the quality of accounting information disclosed. Thanks to more complete and reliable information, shareholders will have a better understanding of the company's management.

4.1. Towards a more relevant audit with high added-value

Audit firms are aware they must modify their audit approach and propose services demonstrating their expertise in digital solutions. The digitalization of audit processes is key to save time on low value-added tasks and analyse all data instead of sampling method.

4.1.1. Time saving and audit orientation towards high added-value tasks

New digital technologies (big data, artificial intelligence, analytics, etc.) are changing the way the audit will be conducted by removing repetitive tasks. New digital technologies allow auditors to save a huge amount of time, to perform certain audit procedures by extracting data automatically, easily and by analysing them through algorithms. In addition, digitalization significantly reduces audit costs.

> "… *The opening/closing of working papers required 3 working days for teams, today with digitalization this task is carried out very quickly*…" (Director 1)

The interviewers confirmed, for time saving, the importance of data collection automation, the digitalization of the circularization process, the automation of the working papers opening, the global reconciliations of the customer's data with the financial statements, the invoice

Table 1
List of interviewees by firm and position.

Audit firm	Number of interviews performed	Partners (Partner 1–5)	Director/Associate Partner (Director 1–4)	Senior Manager (Senior Manager 1–3)	Manager (Manager 1–6)
KPMG	4	1	1		2
Ernst & Young	3	2	1		
Deloitte	4		1	1	2
PricewaterhouseCoopers	4	1	1	1	1
Mazars	3	1		1	1
Total	**18**	**5**	**4**	**3**	**6**
% of Female	28%	20%	25%	33%	33%

checks, etc.:

"*… When an auditor had to control invoices, he had to ask the customer for the ledger and find them, then the customer had to provide him with the evidence. The digitalization of processes allows the customer to have digital invoices, which prevents him from searching them in a folder…* "(Manager 5)

Time saved will allow auditors to focus on high added-value activities such as predictive analysis or judgments evaluation or estimates done by the company's management when closing the accounts. They can also spend more time on errors, irregularities and risk areas, making the audit more efficient and increasing the benefit for the customer. Indeed, one of the respondents emphasizes:

"*The usage of these tools provide us with more time to better perform analysis and to present added-value recommendation, conclusions and ways of improvement… Information from additional controls, such as unusual transactions or atypical transactions, may be done to the customer, who may then investigate the reports if required…* " (Partner 4).

4.1.2. The transition from a sampling method to a complete audit of data

Nowadays, powerful data analysis tools enable auditor to process customer data in a comprehensive way. Rather than manually reviewing a sample's data, the auditor can quickly look at complete data to improve the audit quality and efficiency. The audit files documentation is improved, as digitalization allows a real traceability process, by offering the ability to re-perform the control later. In one hand, the auditor acquires a stronger understanding of the customer and its environment and in the other hand, the audited entity can access to additional information to complete its own risk control:

"*The customer's digitalization… opens opportunities, first to develop our processes and then to develop new tools that drastically change our audit approach. Moving from a sampling method, … to complete data. … nevertheless, the opportunity to offer digital services, remains limited to few customers …* " (Partner 3).

4.2. Evolution of the audit offer and development of new services

Respondents pointed out that shareholders and managers often perceive audit as a necessary and mandatory cost but with limited value for the business. Therefore, audit firms must increase the relevance of the audit and its added-value perception by the customers by proposing new digital services. All interviewees considered that new digital technologies such as, data mining, data analytics, cloud and cognitive technologies, etc. will increase the audit relevance.

4.2.1. Data mining

Data mining can be defined as a process used for the extraction of accurate data within big data. Most interviewees stated that Data Mining can allow the visualization of data workflow compared to predefined workflow to identify exceptions and analyses them (data transformation, data visualization). However, interviewees all agreed that, one of the biggest challenges for their businesses today, is to collect data in a secure way and usable format that can be integrated into audit firm's tools:

"*… Data mining process allows us to extract data directly from SAP system (i.e.), as often as necessary in the workflow process: supplier's list, orders, shipment documents, receipt, invoice …* (Partner 2).

4.2.2. Data analytics

Data analytics is the science of analysing, interpreting and communicating data to improve the effectiveness of decision-making. With data analytics, auditors can provide their customers with recommendations and benchmark including indicators and statistics. The analysis of raw data, displayed in the expected format for a quick interpretation, will allow auditors to submit relevant and accurate conclusions. In addition, deeper insights into risks and trends can represent an important added-value for customer. The evaluation of risk is sometimes complicated for the board of directors thus a deeper analysis could help them in their decision-making process. Furthermore, some interviewees highlighted that analytics and other digital tools such as machine learning, data transformation, data visualization, data mining, allow auditors to identify unusual transactions within customer's system.

"*…Data analytics can compare paths used with the recommended paths, i.e.: what happened and what was supposed to happen … thus, we can quickly identify parallel paths that may be justified or not, but which could be sources of ineffectiveness….* " (Partner 1).

Indeed, by using algorithms and comparing the way information is processed, auditors can identify all exceptions and anticipate potential issues. This type of analysis, allowing customers to improve their processes and their systems, is highly appreciated:

"*… we asked feedback from our customers to find out if they found the Data analytics tools useful, if they saw an interest or a change … Customers are generally satisfied …*" (Partner 5).

4.2.3. Cloud and cognitive technologies

Cloud and cognitive technologies impact auditor's methodology and optimize the control processes. Cloud allows the storage of data or software on remote servers usually stored on computer. Cognitive Technology consists on training a machine to think like an auditor based on the concepts of both machine learning and AI. These technologies will, of course, not replace the auditor's judgment, but rather assist him in decision-making by offering possible solutions that the software has learned from past practices and experiences. Several respondents highlighted the impact on the way auditing is conducted today and on efficiency and relevance. *"AI will be well represented in future audit approaches and several other tools that are developing in the market will make the audit more relevant. The auditor, assisted by technology, will dedicate more time to interpret data. He will also be able to control the customer's data in real time and this is where he can provide the customer with added value …"* (Director 2).

Cognitive technologies monitor the customer's systems and propose solutions to errors or anomalies identified in real time. These technologies can drastically improve the audit quality and evolve the audit offer towards services with stronger added value as customers could correct these errors, prevent risks and continuously improve their systems. Moreover, auditors can include predictive component to provide firms with support for the creation of forecasts or validation of estimates.

" *One day we will evolve the system towards a predictive component, we are not here yet … predictive of provisions, income according to certain parameters … now its use is very limited to a certain number of activities such as retail, but we know that it will happen, …*" (Senior manager 2)

On the same subject, one senior manager stated: "*… In the coming years, the Data analytics and artificial intelligence could allow auditors to include in their analysis forecast data to know what the sales will be, what will be the booking in the next six months or if the planned booking is reliable…*".

In addition, cognitive technologies will allow auditor to collect and analyse business information from non-traditional sources such as social networks, TV, radio, Internet, and determine by analysing the risks and opportunities, whether this information could have an impact on audit. With this new service, audit firms evolve their offer and make it more relevant.

"The new digital technologies will allow the exploitation of new data such as the existing one on internet, social media or other to better understand the customer's business, identify audit risks and also understand the trends regarding the customer's business sector…" (Senior manager 1)

4.3. Improvement of audit quality

Respondents highlighted the importance of using new technologies to ensure the quality of the audit and to provide them with smarter analysis in real time. In addition, they pointed out the importance of supervision of these changes by regulators.

4.3.1. Smart analysis

According to most respondents, audit quality will be improved by digitizing audit firms and by using new analytics and robotics tools. Firstly, as seen previously, the automation of several repetitive audit tasks improves the quality of the preliminary checks and greatly reduces the errors. Then, the smart analysis of data allows a better understanding of the customer's activities, its internal processes, the accounting schemes used and consequently a better understanding of the risks. In addition, cognitive technology and AI will assist the auditor in his decision-making by performing certain tasks in an automatic way and presenting him with scenarios based on historical practices. Finally, these new tools allow the transition from a risk-based approach to an approach analysing all data, which allow firms to deliver a smarter and more relevant service to their customers. Firms no longer based their judgement on data analysis using the sampling method, which may vary according to the levels of estimated risks, but rather on the analysis of global data. Exceptions, deficiencies and anomalies can easily and quickly be identified:

"*…Optimize our processes to deliver a smarter service, not necessarily a new service because the audit will always control information, but in a smarter way to improve the quality of audit: analysing data, making them valuable, so we have to be more relevant in our audit. We keep a risk approach, but we are looking for exceptions, the processes will highlight not expected results … we are looking for the gap … so we provide our customer with more comfort … because in the past we were more on a sampling method today we will inform our customer that we will analyse all data to identify potential issues…*" (Senior Manager 3).

4.3.2. Real timing analysis

Moreover, results show that audit processes 'digitization will help to improve peer review and practice monitoring. Today these very important controls are done generally once the audit is performed, which is not very efficient and does not allow an early detection of anomalies. Indeed, in the current state, these controls require complicated coordination to supervise the different audit files and synchronize the data. Digital technologies will enable audit teams to collaborate in real time and will allow peer review in real time, which will enhance the audit quality.

"*the audit process can take advantage of new technologies to develop real-time dashboards that can be leveraged by audit firms to better monitor audit quality. These tools can alert firms in real time if issues are detected. The emergence of the cloud, artificial intelligence, robotics, and analytics now offer the possibility of very significant progress in terms of audit quality."* (Partner 3).

4.3.3. Regulations

In addition, respondents pointed out that the improvement of the audit quality is now prevented by regulators (H3C, PCAOB, IFAC …). Audit standards which remained at the level of the auditor's risk-based approach do not yet include the capability to address the completeness of data. The auditor's profession is a highly regulated profession and the evolution of legislation and auditing standards is key to improve the audit quality. Most respondents states that the ability to process all data instead of sampling will lead regulators to revise all audit standards based on the risk approach by integrating the technology dimension and its potential uses. Several standards are concerned including: ISA 315, ISA 320, ISA 330, ISA 501, ISA 500[5]. According to interviewees, regulators must answer new questions: how to build audit evidence based on digital data? Should the notion of materiality be revised? which prudential rules to obtain customer data securely? What are the new risks to consider in the use of Big Data and how to take them into account in the audit process?,etc. Respondents believe that this evolution will take longer to achieve and that this is a matter of time:

"*…the regulators (H3C, PCAOB, IFAC ….) must evolve … this is blocking us as regulator has been stuck at the level of the risks audit approach … even at the level of the standards audit … the link between global data analysis and the audit methodology is not yet fixed, this gateway is not yet developed. … Standards have not yet evolved, this slowed down the evolution, but it's just a matter of time….*" (Manager 3).

4.4. Towards on new auditor's profile and the incarnation of an innovation culture

According to the respondents, the change of paradigm, implied by the implementation of digital technologies, has a direct impact of the auditor's profile and on the culture of audit firms now focussed on integrating a culture of innovation.

4.4.1. Paradigm shift

Otherwise, several respondents argue that nothing can change without the involvement of audit teams and the implementation within audit firms of the added-value culture. With this change of paradigm, Auditors should move from the simple fulfilment of checklists to an

[5] ISA 315: Identifying and Assessing the Risks of Material Misstatement through
ISA 320: Materiality in planning and performing an audit.
ISA 330: The Auditor's Responses to Assessed Risks.
ISA 501: Audit Evidence - Specific Considerations for Selected Items.
ISA 500: Audit Evidence.

added-value culture improving customer's system and procedures.

"The digital transition of audit firms will introduce a new culture of adding value to the customer and providing satisfaction. As a result, customer satisfaction and added-value during the mission will be key variables in measuring employee performance and determining career development…" (Director 3).

With the digitalization, audit firms should change their billing approach by moving from a charged hours model to a model including research and development fees:

"*The model needs to evolve because the software and hardware component are becoming more important to us … and we need to collectively advance this understanding with our customer to accept other billing models: our fees represent the knowhow plus software and development and it's a big challenge for us and for the whole profession to change attitudes…*" (One partner coordinator of innovation in a big).

4.4.2. Auditor's profile

Our results show that digital technologies will have a strong impact on future auditor profile and create a culture of innovation. All respondents emphasized that, in addition to knowledge management, the future auditor must feel comfortable with digital tools. He must have the skills to understand how customer's data are designed and generated. He must also have the competencies to extract, analyse data and finally develop skills in designing control tools and interpreting data. Clearly, all interviewees stated that the audit profession needs new talents, more comfortable in analysing and processing data, as well as talents that can develop new audit tools to propose added-value to customers. The audit was previously perceived as a repetitive work, very demanding explaining their significant turnover. With the new technologies (cloud, analytics, robotics, etc.), firms will be able to improve their attractiveness since the audit work will be partly automated, so less repetitive, and more challenging and stimulating.

"*Tomorrow's audit would encourage auditors, including young people, to use their talents, skills and experiences to improve the audit process, bring more value to the mission. the audit of the future requires a deep training and experience in data processing and analysis and especially in the use of new technologies."* (Partner 5)

Beyond digital technical skills, several respondents highlighted that the future auditor must demonstrate skills in critical thinking, considered by the respondents as a state of mind, to improve the monitoring and analysis of data and consequently increase the audit quality. A Director said *"critical thinking will become an essential quality for the auditing profession and all employees must challenge themselves, open up and keep up-to-date on the evolution of the environment… It can develop auditor's curiosity and allow them to be creative and innovative, which will improve customer satisfaction …."* (Director 4).

4.4.3. Culture of innovation

According to most interviewees, the digitization of companies has led audit firms to create a culture of innovation by creating research laboratories and new structures of innovation to identify potential issues of digitalization at local and global level. They acquired several start-ups specializing in digital technologies and employed specialists in digital, robotics, blockchain, etc. Finally, some audit firms worked with incubators on joint projects to investigate developments and implications for their activities.

"*…the acquisition of skills through recruitment and purchase of start-up companies … the first strategy is to understand what is happening on the market, once we understand, we must estimate the consequences on our business … We also work with incubators, on fundamental questions: will our job be assigned for a short term and if yes, how …* " (Senior manager 1).

4.5. Audit process and corporate governance

Based on respondents, the evolution of audit processes will directly impact the corporate governance modifying the relationships between managers and board of directors, board of directors and shareholders but also between companies and creditors.

4.5.1. From managers to board of directors

According to most respondents, the technological evolution of the audit will improve the corporate governance at different levels: (1) Time saving, (2) added-value tasks, (3) complete data analysis and (3) higher level of quality with the ability to detect anomalies, errors or misappropriation in the financial statements. New digital tools can reduce the asymmetry of information between managers and board of directors, and thus enable the audit to play its full role as a governance mechanism allowing the board of directors and stakeholders to take decisions based on a more reliable and transparent accounting information.

"*Today, the audit is done by sampling, tomorrow the audit will cover all of the customer's data and therefore the discretionary attitude of managers will be limited … and with a more transparent information the directors' board and the different shareholders will be in a more comfortable situation to take decision….*" (Partner 4).

4.5.2. From board of directors to shareholders

Most interviewees stressed that for shareholders, the analysis of global data in real time can increase their confidence about statistics provided by board. They also stated that reliable forward-looking data help investors in their investment decision-making. Digital technologies will contribute to reassure stock market and allows it to predict the performance of firms with a higher level of confidence. Thus, data analysis become a real governance tool by reducing information asymmetry between managers and investors, by retaining them and increasing their level of satisfaction and trust in firms.

"Overall everyone is a winner since the confidence in the accounting data disclosed will certainly be improved, which promotes better decision-making by directors and investors and reassure the stock market …" (Partner 3).

4.5.3. From firm to creditors

Overall, our results reveal that the audit's digital evolutions should have an impact on other stakeholders such as banks. With better information (completer and more reliable), banks will be able to better analyses and anticipate the strategy of audit's firms. Creditors will have a better assess the company's sustainability and future ability to reimburse debt.

"*…Taking current and forecast data into account in the audit process will further enhance the confidence of investors and creditors in the published accounting information, …that means a governance based on good information"* (Partner 1).

5. Discussion/implications and contributions

5.1. Discussion/implications

The purpose of this paper was to study the influence of digitalization on the auditor's profession, and to identify potential improvement of the audit role as a governance mechanism. Our results show that the digitization influences the auditor's profession regarding at least five key elements:

First, the audit will become more relevant and will add value to the customer. Respondents confirmed that digitalization will allow the

auditor to save time on boring and repetitive tasks, which is aligned with previous studies on Robotic Process Automation (Moffit et al., 2018). In addition, audit can focus on more added-value task for the customer. Our findings are consistent with Lombardi et al., (2015) research showing that digitalization could help auditing companies to optimize the operational flow by reducing the timing of data collection and proposing advanced prognostics solution, optimizing and automatizing the processes, improving productivity and efficiency. Nevertheless, time saving does not necessary means cost savings as audit firms will have to support the Research & Development costs (algorithm development, equipment's, software) including the hiring cost of competences such as data scientists (Golia, 2013). Moreover, digitalization will transform current audit practices from a sampling approach (risk approach) to one that uses data exhaustiveness. This confirms the results of Kitchin (2014) and Cao (2015) who find that auditors could use big data to perform a continuous auditing on a total population of documents instead of using a sampling method.

Secondly, audit firms could extend their offer by proposing new services such as real-time auditing, data exhaustively analysis of some systems and processes, validation of forecast data, etc. Digitalization is indeed a considerable opportunity for audit firms to improve their offer and their image to the various stakeholders who perceive the audit as a cost without much added value.

Thirdly, digitalization will improve audit quality. New digital tools, comprehensive data processing and the coverage of all customer data will allow a more relevant analysis of the various customer's processes and detect most errors, anomalies in the financial statements and control systems. This is in line with work on big data, which shows that moving to full data use could improve the quality of financial statements (Lombardi et al, 2015; Krahel and Titera, 2015) and anomalies detection (Cunningham and Stein, 2018).

Fourthly, a new auditor profile is emerging to better meet the needs of audit firms and support them in their digital transformation. Indeed, the auditor will have to expand their professional competences and to develop specific skills especially in data analysis or new control tools management. Even if auditors do not need to be an expert in program development, they must have a technological or innovation palatability especially in data analytics and visualization and feel comfortable with new innovative tools. Based on Krahel and Titera (2015), the audits standards defining the training and skill of the auditors must be updated to consider the specificities of the audit data analytics requiring some expertise to use specific technology (Software and Hardware) for a deep audit (Cao et al, 2015). Audit firms will have to attract new talents with new competencies using digital tools and some specific tasks will be made obsolete through their implementation. (Richins et al., 2017). Therefore, one of the managerial issues will be for education institution to implement specific programs dedicated to the digitalization of audit functions (Lombardi, et al., 2015).

Finally, digitalization will enable the implementation of a culture of innovation within audit firms that must constantly innovate and evolve their audit processes and tools to meet the changing needs of their customers. This result goes in the same direction as the study of Rao and Weintraub (2013) which shows that the integration of an innovative culture within a company encourages its employees to change and to be more proactive. Innovation will also be a central element in evaluating audit and career progression of collaborators. If this culture of innovation is missing, there is a risk that other economic actors will arrive to compete with audit firms by offering their services. In this context, Richins et al. (2017) point out the competition in the market could lead companies like Google or FinTech start-ups to decide to offer audit services. In order to avoid this threat, large audit firms are implementing the digitalization of their processes mainly to fit with a changing environment, differentiate themselves and be more competitive. This strategic orientation obviously required human and technological investments and audit firms need to rethink their working procedures (Dai and Vasarhelyi, 2016). Our results also show that to integrate new technologies, and to create their own tools for analysis and control of data, audit firms have adopted strategies of (1) – recruitment of experts in the digital field and data analysis. (2) – acquisition of specialized start-ups in digitalized audit. (3) – creation of their own research and innovation laboratories and (4) – collaboration with external incubators on joint projects to gain a better understanding of market developments and their implications for their activities.

Digital technology will enable the audit to evolve towards a better control of the customer's data and towards an improvement of the relevance and quality of audit. New digital tools and the coverage of all customer data will allow a more relevant analysis of the various processes and data of the customer and identify most errors and anomalies in the financial statements. This will allow the audit to fully play its role as a governance mechanism and become a resource to limit the discretionary power of managers but also a tool to inform them in their decision-making. Moreover, the evolution of the audit offer towards a real-time audit and towards the validation of the forecast data will further limit the risk of misappropriation and the opportunistic behaviours of the managers. Evolving auditing through digitization will also improve the transparency of financial statements and enable the board of directors to take the right decisions. Finally, this audit's technological evolution could also enable the audit committee to improve the internal systems and processes to produce accounting information based on the recommendations made by the auditors. This would also limit the risk of earning management by directors and improve corporate governance. In addition, changes in the audit should also have an impact on other investors (shareholders and bankers). With better information (completer and more reliable), they will be able to better control the managers 'actions and retain the main shareholders of the company.

The success of the digital transformation of audit firms and the evolution of their service offerings depends on two key elements. First, firms need to invest in data security to reassure their customers and build trust for data transfer. Secondly, they must implement policies to include the culture of innovation at every level of the profession to keep up-to-date technology and constantly evolve their service offerings. In addition, audit firms need to deal with legislative and normative issues that could affect them. Indeed, while new technologies are evolving and enabling comprehensive data analysis, the current legislation on data transfer and security and privacy rules, as well as auditing standards need to be updated as digital business is moving quickly. Several audit standards must evolve by integrating new technologies, mainly all the norms related to the risk approach (ISA 315, ISA 320, ISA 330, ISA 501, ISA 500), but also the rules of ethics which must take into consideration how auditors can exercise their profession in all independence respecting professional ethics in this new environment. As a result, big data analysis offers huge opportunities for audit firms, but also carries some risks given the current legislation. The question that arises today is, do these technological changes will encourage regulators to evolve the audit?

5.2. Contribution

This study contributes to the literature on corporate governance and audit in general and in digital transformation of audit firms more specifically. It demonstrates that digital technology will transform the audit role as a governance mechanism and limit the discretionary power of managers. It also contributes to enrich the work on audit quality and highlight the need to change audit standards by integrating new technologies. On the managerial level, this research highlights for both auditors and their customers the issue of the digital transformation

of firms, its implications on auditing practices and the new constraints associated with them. In their digital transformation' process, firms can use several recommendations. As a summary, audit firms could:

- Appropriate technologies and invest in the training of their employees and associates.
- Digitalize repetitive and low added value processes to improve their brand image in the market.
- Reflect on a new organization of audit teams and a new allocation of roles taking into account the digitization of certain processes and allowing the optimization of the audit process.
- Set up research laboratories and develop partnerships with incubators or other digital players on issues related to the development of new tools for data extraction and control, etc.
- Establish a culture of innovation at all levels in order to remain attentive to market developments and to constantly evolve audit services.
- Set up teams to work on the security of customer data transfers and to collect data in a way compatible with the firm's tools.
- Establish a new recruitment policy focusing on skills and new talent of digital (data scientists, data analysts…) and dual skills profiles (double degree engineering school and business school).

5.3. Limitation & future researches

Our research is not free from methodological limitations. The results of this research cannot go beyond the exploratory framework given the size of our sample (18 auditors). In addition, our methodology could be completed by a participatory qualitative study that remains difficult to obtain. New research tracks can complete this work. First, it is essential to study how the digitalization of internal audit processes could improve corporate governance. Moreover, it is important to examine whether the digitalization of internal control systems would improve audit committees 'role as a governance mechanism and limit the opportunistic behaviours of managers. In the audit field, it is also interesting to study the impact of digitalization on small audit firms that do not have the resources of large firms to appropriate the technology and develop new offers. Finally, it is important to examine the effects of digitization on the recruitment policy of audit firms.

References

Abbott, L.J., Parker, S., Peters, G.F, Raghunandan, K., 2003. An empirical investigation of audit fees, non-audit fees, and audit committees. Contemp. Account. Res. 20 (2), 215–234.

Al-Htaybat, K., Von Alberti-Alhtaybat, L., 2017. Big Data and corporate reporting: impacts and paradoxes. Account., Audit. Account. J. 30 (4), 850–873.

Andon, P., Free, C., Sivabalan, P., 2014. The legitimacy of new assurance providers: making the cap fit. Account. Org. Soc. 39 (2), 75–96.

Appelbaum, D.A, Kogan, A., Vasarhelyi, M.A., 2018. Analytical procedures in external auditing: a comprehensive literature survey and framework for external audit analytics. J. Account. Lit. 40, 83–101.

Arnaboldi, M, Busco, C., Cuganesan, S., 2017. Accounting, accountability, social media and big data: revolution or hype? Account., Audit. Account. J. 30 (4), 762–776.

Ashbaugh, H., Warfield, T.D., 2003. Audits as a corporate governance mechanism: evidence from the German market. J. Int. Account. Res. 2, 1–21.

Beisland, L.A, Mersland, R, Strom, R.O., 2015. Audit quality and corporate governance: evidence from the microfinance industry. Int. J. Audit. 19 (3), 218–237.

Brennan, N.M., Solomon, J., 2008. Corporate governance, accountability and mechanisms of accountability: an overview. Account., Audit. Account. J. 21 (7), 885–906.

Brown-Liburd, H., Hussein Issa, H., Lombardi, D., 2015. Behavioral implications of big data's impact on audit judgment and decision making and future research directions. Account. Horiz. 29 (2), 451–468.

Cao, M., Chychyla, R., Stewart, T., 2015. Big Data analytics in financial statement audits. Account. Horiz. 29 (2), 423–429.

Carcello, J.V., Hermanson, D.R, Zhongxia, Y., 2011. Corporate governance research in accounting and auditing: insights, practice implications, and future research directions. Auditing 30 (3), 1–31.

Cunningham, L.M., Stein, S.E., 2018. Using visualization softwares in the audit of revenue transactions to identify anomalies. Issues Account. Educ. 33 (4), 33–46.

Dai, J., Vasarhelyi, M., 2016. Imagineering Audit 4.0. J. Emerg. Technol. Account. 13 (1), 1–15.

DeAngelo, L., 1981. Auditor independence, low-balling and disclosure regulation. J. Account. Econ. 3 (2), 113–127.

DeFond, M., Zhang, J., 2014. A review of archival auditing research. J. Account. Econ. 58 (2/3), 275–326.

Dengler, K., Matthes, B., 2018. The impacts of digital transformation on the labour market: substitution potentials of occupations in Germany. Technol. Forecast. Soc. Change 137, 304–316.

Dinesh, N., Juvanna, I., 2017. Dynamic auditing and deduplication with secure data deletion in Cloud. Artificial Intelligence and Evolutionary Computations in Engineering Systems. Springer, pp. 305–313.

Dumitru, C., 2016. The digital revolution and job polarization: an institutional, economic, and social issue. Intern. Audit. Risks Manage. 11 (2), 105–115.

Francis, J.R., Wang, D., 2008. The joint effect of investor protection and Big 4 audits on earnings quality around the world. Contemp. Account. Res. 25 (1), 157–191.

Francis, J.R., Maydew, E.L., Sparks, H.C., 1999. The role of Big 6 auditors in the credible reporting of accruals. Auditing 18 (2), 17–34.

Freeman, R.E., 1984. Strategic Management: A Stakeholder Approach, Latest ed. Pitman, Boston, MA, pp. 46.

Gepp, A., Linnenluecke, M.K., O'Neill, T.J., Smith, T., 2018. Big data techniques in auditing research and practice: current trends and future opportunities. J. Account. Lit. 40, 102–115.

Gillham, B., 2000. Case Study Research Methods. Bloomsbury Publishing, pp. 106.

Golia, N., 2013. What Big Data means for infrastructure costs? Insur. Technol. 30–31.

Griffin, P.A, Wright, A.M., 2015. Commentaries on Big Data's importance for accounting and auditing. Account. Horiz. 29 (2), 377–379.

Hope, O.-K., Kang, T., Thomas, W., Yoo, Y.K., 2008. Culture and auditor choice: a test of the secrecy hypothesis. J. Account. Public Policy 27 (5), 357–373.

Issa, H., Sun, T., Vasarhelyi, M.A., 2016. Research ideas for artificial intelligence in auditing: the formalization of audit and workforce supplementation. J. Emerg. Technol. Account. 13 (2), 1–20.

Jeacle, I., 2014. And the BAFTA goes to […]: the assurance role of the auditor in the film awards ceremony. Account. Audit Account. J. 27 (5), 778–808.

Jeacle, I., 2017. Constructing audit society in the virtual world: the case of the online reviewer. Account., Audit. Account. J. 30 (1), 18–37.

Jensen, M.C., Meckling, W.H., 1976. Theory of the firm: managerial behavior, agency costs and ownership structure. J. Financ. Econ. 3 (4), 305–360.

Jahera Jr., John S., 1988. The role of the audit and agency theory. J. Appl. Bus. Res. 4 (2), 7–12.

Kim, D., Song, S., Choi, B-Y., 2016. Data Deduplication for Data Optimization for Storage and Network Systems. Springer, pp. 3–21.

Kitchin, R., 2014. Big Data, New Epistemologies and Paradigm Shifts. Big Data and Society April/June 1-12.

Kogan, A., Alles, M.G., Vasarhelyi, M.A., Wu, J., 2014. Design and evaluation of a continuous data level auditing system. Auditing 33 (4), 221–245.

Kokina, J., Davenport, T.H., 2017. The emergence of artificial intelligence: how automation is changing auditing. J. Emerg. Technol. Account. 14 (1), 115–122.

Krahel, J.P., Titera, W.R., 2015. Consequences of big data and formalization on accounting and auditing standards. Account. Horiz. Am. Account. Assoc. 29 (2), 409–422.

Krippendorff, K., 2004. Measuring the reliability of qualitative text analysis data. Qual. Quant. 38 (6), 787–800.

Leuz, C., Lins, K.V., Warnock, F.E., 2009. Do foreigners invest less in poorly governed firms? Rev. Financ. Stud. 22 (8), 3245–3285.

Lombardi, D.R, Bloch, R, Vasarhelyi, M.A., 2014. The future of audit. J. Inf. Syst. Technol. Manage. 11 (1), 21–32.

Lombardi, D.R, Bloch, R, Vasarhelyi, M.A., 2015. The current state and the future of the audit profession. Curr. Issues Audit. Am. Account. Assoc. 9 (1), 10–16.

McKee, T.E., Lensberg, T., 2002. Genetic programming and rough sets: a hybrid approach to bankruptcy classification. Eur. J. Oper. Res. 138 (2), 436–451.

Meier, C., 2017. Managing digitalization: challenges and opportunities for business. Management 12 (2), 111–113.

Miles, M.B., Huberman, A.M., 1994. Qualitative Data Analysis: An Expanded Sourcebook. Sage.

Moffitt, K.C., Rozario, A.M., Vasarhelyi, M.A., 2018. Robotic process automation for auditing. J. Emerg. Technol. Account. 15 (1), 1–10.

Montes, G.A., Goertzel, B., 2018. Distributed, decentralized, and democratized artificial intelligence. Technol. Forecast. Soc. Change. https://doi.org/10.1016/j.techfore.2018.11.010.

Nambisan, S., Lyytinen, K., Majchrzak, A., Song, M., 2017. Digital Innovation management: reinventing innovation management research in a digital world. MIS Q. 41 (1), 223–238.

Nigrini, M.J., 2018. Round numbers: a fingerprint of fraud. J. Account. 225 (5), 1–9.

Pendharkar, P.C., 2005. A threshold-varying artificial neural network approach for classification and its application to bankruptcy prediction problem. Comput. Oper. Res. 32 (10), 2561–2582.

Porter, M.E., Heppelmann, J.E., 2014. How smart, connected products are transforming competition. Harv. Bus. Rev. 92, 11–64.

Rao, J., Weintraub, J., 2013. How innovative is your company culture? MIT Sloan Manage. Rev. 54 (3), 29–37.

Raphael, J., 2017. Rethinking the audit. J. Account. 223 (4), 29–32.

Richins, G., Stapleton, A., Stratopoulos, T.C., Wong, C., 2017. Big data analytics: opportunity or threat for the accounting profession? J. Inf. Syst. 31 (3), 63–79.

Sahut, JM., Peris-Ortiz, M., 2014. Small business, innovation, and entrepreneurship. Small Bus. Econ. 42 (4), 663–668.

Sahut, JM., Hikkeorva, L., Moez, K., 2013. Business model and performance of firms. Int. Bus. Res. 6 (2), 64–76.

Sajady, H., Dastgir, M., Nejad, H.H., 2008. Evaluation of the effectiveness of accounting

information systems. Int. J. Inf. Sci. Technol. 6 (2), 49–59.
Strauss, A., Corbin, J., 2008. Basics of Qualitative Research, third ed. Sage Publication, Thousand Oaks Edition.
Van Den Broek, T., Van Veenstra, A.F., 2018. Governance of Big Data collaborations: how to balance regulatory compliance and disruptive innovation. Technol. Forecast. Soc. Change 129, 330–338.
Vasarhelyi, M.A., Kogan, A., Tuttle, B.M., 2015. Big Data in accounting: an overview. Account. Horiz. 29 (2), 381–396.
Wallace, A.W., 2004. The economic role of the audit in free and regulated markets: a look back and forward. Res. Account. Regul. 17, 267–298.
Wamba, S.F., Akter, S., Edwards, A., Chopin, G., Gnanzou, D., 2015. How 'big data' can make big impact: findings from a systematic review and a longitudinal case study. Int. J. Prod. Econ. 165, 234–246.
Warren, D., Moffitt, K., Byrnes, P., 2015. How accounting records will change with Big Data. Account. Horiz. 29 (2), 397–407.
Watts, R., Zimmerman, J., 1986. Positive Accounting Theory. Prentice-Hall, Englewood Cliffs, New Jersey.
Yang, D., Jiao, H., Buckland, R., 2017. The determinants of financial fraud in Chinese firms: does corporate governance as an institutional innovation matter? Technol. Forecast. Soc. Change 125, 309–320.
Yoon, K., Hoogduin, L., Zhang, L., 2015. Big data as complementary audit evidence. Account. Horiz. 29 (2), 431–438.
Zhang, J., Yang, X, Appelbaum, D., 2015. Toward effective big data analysis in continuous auditing accounting. Horiz. Am. Account. Assoc. 29 (2), 469–476.

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