

Big Data, Data Analytics and External Auditing

Dimitris Balios, Panagiotis Kotsilaras, Nikolaos Eriotis, Dimitrios Vasiliou
National and Kapodistrian University of Athens, Athens, Greece

Big Data and Data Analytics affect almost all aspects of modern organisations' decision-making and business strategies. Big Data and Data Analytics create opportunities, challenges, and implications for the external auditing procedure. The purpose of this article is to reveal essential aspects of the impact of Big Data and Data Analytics on external auditing. It seems that Big Data Analytics is a critical tool for organisations, as well as auditors, that contributes to the enhancement of the auditing process. Also, legislative implications must be taken under consideration, since existing standards may need to change. Last, auditors need to develop new skills and competence, and educational organisations need to change their educational programs in order to be able to correspond to new market needs.

Keywords: Big Data, Data Analytics, auditing, accounting

Introduction

Technological development has generated new standards and new ways of collecting and analyzing data. Interconnections via Internet and constant exchange of information among different systems have created vast amounts of data available for analysis. It is indicative that these “Big Data” are continually growing in volume and need sophisticated tools, called Data Analytics, to try to retrieve relevant information (Horak & Boksova, 2017). Big Data represents a growing market which is estimated to reach \$67 billion by 2021, with Data Analytics software being the market leader. More than 98% of stored information worldwide is electronic, and the business community has accepted this new type of information since it can be beneficial. Traditional ways of analysing data are no longer helpful and new, and sophisticated tools are needed. Data analytics software programs provide such tools (Cukier & Mayer-Schonberger, 2013; Rezaee & Wang, 2019).

In order to remain competitive, modern companies and organisations are willing to use cloud and Internet data sources, like Social Media. Also, sophisticated analytical tools are used to help business professionals make efficient decisions on strategy implementation. Auditors need to audit clients who use Big Data and Data Analytics in doing business. Thus, external auditors face a new reality and need to use advanced predictive as well as prescriptive oriented analytics (Appelbaum, Kogan, & Vasarhelyi, 2017).

Dimitris Balios, Ph.D., assistant professor, Department of Economics, National and Kapodistrian University of Athens, Athens, Greece.

Panagiotis Kotsilaras, Ph.D. candidate, Department of Economics, National and Kapodistrian University of Athens, Athens, Greece.

Nikolaos Eriotis, Ph.D., professor, Department of Business Administration, National and Kapodistrian University of Athens, Athens, Greece.

Dimitrios Vasiliou, Ph.D., professor, Department of Economics, National and Kapodistrian University of Athens, Athens, Greece.

Researchers provide several definitions for Big Data. Both terms, “Big” and “Data” are relative concepts. A set of data can be considered “Big” when it makes the information system to reach its maximum capacity or even be unable to accomplish a specific task (Vasarhelyi, Kogan, & Tuttle, 2015). Besides, the meaning of Big Data differs among its users. The amount of data which is considered “Big” for an ordinary firm may be of no importance for a multinational company. Thus, whether Data are Big or not is determined by “whether these data push the limit of capabilities of information systems that work with these data” (Vasarhelyi et al., 2015, p. 382).

The purpose of the article is to present the existing literature on the impact of Big Data and Data Analytics on External Auditing. Big Data is expected to continue spreading in the entrepreneurial world, and external auditing needs to become competent in terms of knowledge and implementation of new techniques. Besides, Big Data creates an opportunity for further enhancement of the auditing process by integrating financial and non-financial information. The present article contributes to the existing literature on the subject, by offering a thorough analysis, useful for anyone—professional or not, in order to acquire a general, yet precise knowledge on this critical issue.

The article focuses on the impact of Big Data and Data Analytics on external auditing and is structured as follows: First, we refer to Big Data use on accounting and external auditing procedures, regarding different aspects pointed out by researchers. Then, we discuss the impact on the audit practice and effectiveness. Furthermore, we present the main challenges, concerns, and implications for the audit community. Last, future benefits and conclusions follow.

Big Data in Accounting Practices

Financial reporting is the primary task of accounting. Financial reporting refers to a lot of different business activities which lead to a transaction and its primary purpose, which is to record the transaction. In this way, business measurements are created (Vasarhelyi et al., 2015). The emergence of Big Data has changed the nature of business measurements in the sense that financial activities are traced and measured more effectively and at an earlier point (Romero, Gal, Mock, & Vasarhelyi, 2012). In this framework, accounting reporting seems to have lost its informational value, since the economy is supported by real-time processes (Vasarhelyi & Greenstein, 2003), while financial reports are issued on a quarterly or annual basis (Kraheil & Titera, 2015).

Big Data can be very useful in accounting practice, and it seems that, in the future, many tasks concerning financial and managerial accounting will be automatically uploaded into informational systems. Paper documents will be minimised in quantity and accounting data will be processed, monitored, and audited online, leading even to the shortening of accounting and taxation period (Horak & Boksova, 2017). Accountants’ tasks will change since they will not just be responsible for preparing financial statements, but they will have more strategic and proactive roles (Gamage, 2016). Big Data creates opportunities and challenges for the accounting profession which refer to the integration of finance, technology, and information.

New financial and non-financial measurements need to be developed, and new guidelines are needed to standardise these measurements (Vasarhelyi et al., 2015). Students and new professionals need to be adequately trained, and educators have to assure that they adapt learning to the new, global challenges and trends (Janvrin & Watson, 2017). Griffin and Wright (2015) stated that: “academics, as educators, certainly must revamp their accounting and auditing curricula to provide the necessary skills for Big Data in the accounting and auditing profession” (p. 379).

An essential application of Big Data is that of forensic accounting. During the last years, forensic accounting has emerged as a vital accounting practice. It is a practice that is used in order to investigate fraud, corruption, or bribery, while it is highly related to cybersecurity issues (Rezaee, Larry Crumbley, & Elmore, 2004). Thus, the use of Big Data and Data Analytics signify essential tools for forensic accountants, since they can obtain and process massive amounts of diverse information, which comes in structured, semi-structured, or unstructured form (Balios et al., 2020; Balios & Tantos, 2019; Rezaee & Wang, 2019).

Despite the existing literature on Big Data and their effect on accounting practices, researchers argue that the goal of accounting remains the same, which is providing information to decision-makers (Jarvin & Watson, 2017; Capriotti, 2014). Accountants, whichever the source of data is, have always used tools to record, filter, and consolidate these data. Although Big Data poses new challenges for the profession, the accountants have always been used to changes concerning the different types of information provided (Grabski, Leech, & Sangster, 2011; Zhang, Yang, & Appelbaum, 2015).

Implementation of “Data Analytics” in External Auditing

The fundamental objective of external auditing is to provide opinion on the financial statements and precisely judge whether the financial statements present the financial position of the client, according to the accounting principles and standards that are generally accepted (Glover, Prawitt, & Drake, 2014; Yoon, Hoogduin, & Zhang, 2015). More specifically, external auditors need to ensure that the financial statements do not include misstatements. Thus, they must design and implement procedures which can help them obtain appropriate evidence. Also, they need to verify the accuracy of evidence in order to provide their audit opinion. Evidence represents the information obtained, which confirms or contradicts the financial statements' declarations (Appelbaum et al., 2017).

Given the complex modern environment, where IT and Big Data dominate, the evidence that auditors gather has changed in nature and competence (Warren, Moffitt, & Byrnes, 2015; Appelbaum et al., 2017). It is indicative that

Data analytics are altering the way the audit process is done at both the transaction and general-ledger levels. Auditors have new tools to extract and visualise data, allowing them to dig into larger, non-traditional data sets and perform more intricate analysis. (PwC, 2015)

The quantity and the quality of electronic evidence preoccupy auditors, with quality being a significant issue (Appelbaum et al., 2017). The emergence of new forms of data poses challenges and provides opportunities for the auditing process (Vasarhelyi et al., 2015). As already mentioned, researchers attach “Big Data” the following characteristics known as 4V's: Massive Volume, High Velocity, Large Variety, and Uncertain Veracity (Laney, 2013; Zhang et al., 2015). Massive Volume and High Velocity require Big Data Analytics from auditors, since present techniques may seem inadequate (Vasarhelyi, Alles, & Williams, 2010). Modern systems used by firms are complex in structure, provide considerable amounts of data, and interact with other external systems. Data included in this process may have significant implications in financial reporting and may need to be verified (Yoon et al., 2015).

External auditing companies, by implementing Data Analytics, have a powerful tool in their hands. Especially when they need to audit big companies, which have essential amounts of Big Data available, Analytics tools are very useful in enhancing the effectiveness and reliability of the audit results (Dagilienė & Kloviėnė,

2019). By using Data Analytics, auditing companies can better understand the business client's environment, as well as reduce the risk of incorrect conclusions. Big Data, as well as Big Data Analytics, help improve audit quality (Dagilienė & Klovienė, 2019). For example, data mining is a technique which has advanced classification and prediction capabilities and can contribute to fraud detection (Lin, Chiu, Huang, & Yen, 2015).

The market orientation of a company also affects the use of Big Data tools. When companies operate in a small domestic market, data gathered are not so big and traditional auditing methods are adequate. However, when audit clients use Big Data and Business Analytics methods, in order for the auditors to conduct effective and efficient auditing, they need to use advanced techniques. Ratio analysis, trend analysis, as well as scanning represent such techniques (Balios et al., 2016; Glover et al., 2014). Nevertheless, according to researchers, more analytical tools are needed in order to respond to auditing needs. Audit Data Analytics represents the "analysis of data underlying financial statements, together with related financial or non-financial information, to identify potential misstatements or risks of material misstatement" (Stewart, 2015, p. 108). Thus, the use of both analytical and traditional procedures is recommended. Exploratory Data Analysis and Confirmatory Data Analysis are methods which can also be used into the context of audit data analytics (Liu, 2014; Stewart, 2015).

Impact on the Audit Practice and Effectiveness

There is much discussion concerning the importance and effectiveness of Big Data on the audit practice. Auditors have more resources available in order to gather the evidence needed for their audits and opinion statement. They have in their availability a wide variety of information, both financial and non-financial, while the automation of the auditing process can improve the results (Yoon et al., 2015). Besides, the new technologies and techniques that are available can improve the predictive power of data analysis routines and enable auditors' reach data-driven, rather than experience-driven opinions (Russom, 2011).

Big Data can contribute to the effectiveness of auditing, but it can also be confusing. Auditing is successfully implemented when it is "sufficient and appropriate" (Yoon et al., 2015, p. 431). Appropriate means reliable and relevant, while sufficient is related to the volume and variety, and Big Data can contribute to this aspect. When traditional data are not adequately "reliable" or "relevant", then more evidence from Big Data can be useful. Furthermore, Big Data can be more reliable and relevant than traditional sources, even though "noise" may impact on their reliability (Russom, 2011; Yoon et al., 2015).

Researchers also argue that Big Data can be beneficial for auditors in terms of sufficiency. They can provide support when traditional audit evidence is deficient. For example, when auditors try to obtain evidence for fraud, the evaluation of e-mails can be rather useful, while traditional audit evidence is proven inadequate (Holton, 2009). A significant Big Data benefit is that of providing information abundance in multiple forms and vast quantities (Russom, 2011).

As far as reliability is concerned, some types of Big Data can contribute to evaluating the reliability of traditional audit information (Dhillon & Modha, 2001). Besides, Big Data from external sources can provide crucial non-financial evidence which can be used to assess financial accounts. For example, when a product receives adverse comments on Social Media, while the Sales registered in the financial statements have increased, then this could be a sign for further investigation (Yoon et al., 2015).

Relevance is another attribute of the auditing process. The global financial environment in which companies operate represents a vital factor for auditors to analyse. When the general environment is well-known, auditors can better understand their clients' business risks (Yoon et al., 2015). Business risks can

be evaluated using traditional auditing tools, but when new business models such as e-commerce are concerned, Big Data can be proven useful. Big Data Analytics can be used to evaluate different types of businesses as well as different forms of evidence. The fact that Big Data provides unique and timely evidence makes them relevant (Cao, Chychyla, & Stewart, 2015).

Audit evidence represents another aspect of auditing, where Big Data can be effectively implemented. Big Data could identify anomalies for further investigation, especially when the estimated risk of misstatement is high (Larcker & Zakolyukina, 2012). News articles, forums, social media provide Big Data which can be analysed and offer essential information.

Cao et al. (2015) referred to the auditing activities which are enhanced with the use of Big Data Analytics. First, the identification and assessment of the risks which are included in an audit engagement, like the risk of bankruptcy, as well as the risks of misstatements included in the financial statements. Also, Big Data Analytics enables auditors to perform better analytical procedures which are necessary for detecting fraud but also in forming an overall conclusion concerning their judgment on the consistency of financial statements with existing regulations (Gamage, 2016).

The audit practice is changing in terms of the time when the audit process takes place. Traditional auditing is performed once a year, something that may generate problems, since audit data may be gathered long after the events happen. Instead, Big Data Analytics provide the potential of conducting continuous auditing. A continuous audit is a methodology which enables auditors to provide their opinion on a subject, by using a series of reports issued almost simultaneously with the events concerning the specific subject (Alawadhi et al., 2015). Alles, Brennan, Kogan, and Vasarhelyi, (2006) argued that continuous audit can be useful for Continuous Control Monitoring and Continuous Data Assurance. Besides, firms' automated internal audit procedures enable them to save cost, conduct more frequent audits, and minimise audit staff involvement (Alles, Kogan, & Vasarhelyi, 2002; Balios and Zaroulea, 2020).

Main Challenges of Data Analytics

Apart from the effectiveness provided to the auditing process, Big Data usage also involves challenges. A significant challenge concerning Big Data is the fact that there is a substantial shortage of professionals who possess the knowledge and skills to use these demanding tools. The growing demand for such skills denotes a challenge for official educational institutions and new training programs need to be implemented both at the undergraduate and graduate level. Auditors or forensic accountants, as well as other professionals dealing with Big Data and Data Analytics, need to be adequately trained (Wang, Lee, & Crumbley, 2016; Rezaee & Wang, 2019; Balios, 2020). Also, professionals and auditing firms collect vast amounts of Big Data concerning their clients, but they do not know how to analyse and apply them to their business (Earley, 2015). Another challenge of the use of Big Data and Data Analytics is the fact that data can be lost, due to cyber attack, or during the process of data filtering. Moreover, professionals may lose their jobs, since tasks such as registering data, controlling and auditing will be carried out automatically (Horak & Boksova, 2017).

Traditional annual audits may probably be considered meaningless, in the modern technological environment, where information is provided and evaluated on a real-time basis. Thus, audit professionals should consider implementing a progressive audit methodology (Appelbaum et al., 2017). Furthermore, the new, Big Data-based environment consists of sources of information which are novel for auditors and may require re-examining the standards regarding audit evidence (Appelbaum, 2016).

One of the external auditing purposes is to reveal probable fraud. In the new Big Data era, auditors have the chance to gather vast amounts of data. A vast amount of data is not necessarily helpful because of the complexity as well as the quality of such data (Fukukawa, Mock, & Srivastava, 2014; Appelbaum et al., 2017).

Information privacy and information transfer represent two critical challenges concerning the use of Big Data as audit evidence. Information privacy refers to “the ability of the individual to control, personally, information about one’s self” (Stone, Gardner, Gueutal, & McClure, 1983, p. 460). The use of Big Data for detecting fraudulent behaviours involves providing access to e-mails, videos, GPS data, and other sources which are related to information privacy (Yoon et al., 2015). Information transfer is another issue concerning auditing. Auditors may transfer the knowledge and expertise gained by engaging with a client to another auditing procedure. In order to do so, they try to gain access to a wide range of internal data sources. However, collecting and analysing essential amounts of Big Data entails cost, which not all auditing companies can bear. As a consequence, barriers are formed for audit companies to enter specialised industries, where specialised audit firms dominate (Yoon et al., 2015).

Generally, it seems that liability and other concerns, as well as the highly regulated auditing environment, makes auditing firms to be careful in implementing Data Analytics in their practices. Besides, the use of Data Analytics preserves opportunities, as well as critical challenges.

Future Benefits and Implications on the Quality and Cost of External Audits

Many researchers try to reveal the future benefits of Big Data and Data Analytics adoption for accounting practices and, consequently, the external auditing techniques. Warren et al. (2015) argued that Big Data and Data Analytics may contribute to the elimination of disparities between different accounting and reporting standards and “accelerate the movement toward a global accounting regime with fair value accounting as a key cornerstone” (p. 403). If this is the case, external auditors’ task will be much easier, since they will need to examine the correct implementation of a single accounting regime (Griffin & Wright, 2015). Other researchers argue that the future will be substantially different. Krahel and Titera (2015) stated that “Aggregation and arbitrary allocations made on static, paper-based financial statements are artifacts of a bygone era of high transmission costs and slow data collection speeds” (p. 410). They argue that raw data which will be dynamically extracted and examined by the end-user will replace static, paper-based financial information. Auditing will also change in order to follow its clients (Alles, 2015).

Practical applications will also transform the auditing process by offering the potential to analyse detailed rather than summary data, by offering the potential to integrate internal data, external data, and financial data and by offering the potential to integrate the audit processes with environmental Big Data (Kogan, Alles, Vasarhelyi, & Wu, 2010).

External auditors are independent and do not have constant contact with their clients. Thus, they need to understand the environment in which they operate, as well as the aspects of corporate performance and Big Data Analytics, provide a useful tool (Balios et al. 2020; Dagilienė & Klovienė, 2019). Cost represents a factor which deprives audit companies, from using Big Data Analytics. Especially small audit companies usually do not have the financial resources to acquire Big Data Analytics tools as well as to train and educate their employees (Dagilienė & Klovienė, 2019; Alles, 2015). On the other hand, there are ways to minimise cost. Auditors can create their data “warehouses” and reduce cost by achieving economies of scale (Yoon et al.,

2015).

Quality is another implication for external auditors. Big Data sources (e.g., news articles or comments on Social Media) may be affected by biases and not provide quality evidence. Auditors need to bear in mind constantly the specific audit objective as well as the principles that need to characterise evidence; that is sufficiency, relevance, and reliability (Vasarhelyi, 2008; Tang & Karim, 2017). Also, the quality of auditors' judgment may be affected because "Big Data exacerbates the effects of those human limitations, potentially leading to suboptimal auditing judgments" (Griffin & Wright, 2015, p. 379). Last, when evidence is paper-based, it is not easy to alter information, whereas electronic data may be changed easily, and—in the absence of the appropriate control—the change may not be detected (Appelbaum et al., 2017).

Discussion—Concluding Remarks

The audit community faces a new reality and researchers argue that the use of Big Data Analytics may raise issues concerning the International Standards of Auditing (ISA). Researchers support the opinion that ISA may need to change in order to better employ analytic tools (Krahel & Titera, 2015). The new Big Data environment creates a substantial gap between accounting scholarship and practice and accounting scholars and professionals need to focus on the emergence of data standards and audit applications in order to develop existing knowledge (Zhang et al., 2015). On the other hand, audit experts argue that no changes are needed, since auditing standards and other legal acts focus on the principles and purpose of the audit, and are irrelevant of the techniques used to conduct the audit (Dagilienė & Klovienė, 2019).

Another concern is the integration of Big Data with other, more traditional audit evidence. Big Data comes in different forms and are structured in a different way than the one used for presenting traditional auditing evidence. Thus, auditors need to find a "bridge method" to integrate new with traditional evidence (Vasarhelyi et al., 2015). Furthermore, probably, auditors do not have the sufficient familiarisation with Big Data, something that makes it difficult for them to predict in advance their effectiveness, in specific cases (Yoon et al., 2015).

The gap between the adoption of technology by the auditing community and by the professional of management is also an issue which raises questions as to whether the auditing community is willing to adopt new techniques, like the use of Big Data Analytics (Alles, 2015).

Big Data and Data Analytics constitute a revolution in the way business is done and audited nowadays. Firms and organisations around the world use Big Data to develop their strategies better and make decisions. External auditors and the accounting science in general, face new challenges and implications, lack of adequate education being a major one. Technology is evolving day-by-day, and new challenges will arise. Thus, it is vital for theorists, accounting and auditing professional as well as educational organisations to integrate changes in the accounting and auditing profession. External auditors need to develop tools to handle Big Data better and try to make the abundance of evidence sources a critical tool for revealing misstatements and fraud.

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