

FROM BIG DATA TO ARTIFICIAL INTELLIGENCE: THE FUTURE FOR THE AUDITING PROFESSION

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ABSTRACT: *In the history of the auditing profession, there have been many changes in the way financial statements are audited. In recent years, the changes have been the result of various transformations in the environment in which companies operate and in which auditing is carried out. New technologies available today allow us to capture and communicate data digitally and instantaneously on an unprecedented scale. This technological evolution results in a growing interest in data, whether structured or unstructured, internally generated or not. In response to these developments, companies are innovatively changing their business models because they now have information systems that are increasingly capable of processing, analyzing, communicating, and responding to data-related changes. Therefore, how the audit is carried out must also evolve. Thanks to new technologies, auditing has evolved into a more automated one. Today, there are many new technologies and techniques to change the way this is done. Currently, audit firms integrate these methods into their daily audit procedures, as the environment in which these firms operate is characterized by a constant increase in available data. As part of this stack of information, Big Data pushes auditors beyond their comfort zone of traditional auditing methods. The objective of this article is to analyze the impact of emerging technologies, such as Big Data and Artificial Intelligence (AI), on the auditing profession. The article aims to explore how these technologies can transform auditing practices and requirements, bringing with them a range of opportunities and challenges for auditors. The main purpose of this article is to provide a comprehensive perspective on the direction the audit profession is heading in the digital age, highlighting the advantages brought by Big Data and AI technologies, but also the possible changes and adjustments needed within this profession.*

Keywords: *artificial intelligence, audit, companies, financial statements.*

JEL Classification: M42.

1. INTRODUCTION

Throughout history, the auditing profession has seen many significant changes in the way financial statements are audited. In recent years, these changes have been the result of transformations in the business environment and technological advances. New technologies available today have revolutionized the way data is collected and communicated, providing unprecedented scalability. This technological evolution has increased interest in data, whether structured or unstructured, regardless of its source (BinSaeed et al., 2023).

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In response to these developments, companies have begun to adapt their business models innovatively, having access to increasingly advanced information systems capable of rapidly processing, analyzing, and communicating data-related changes. This change required an evolution in the way financial auditing is carried out (Dănăilă et al., 2023).

The chart below illustrates how auditing has changed over time. At first, audit procedures were manual, and audits were based on sampling a limited number of transactions. Then, as technology advanced, auditing became increasingly automated, allowing the use of much larger samples. Technology tools make it possible today to test the entire population of transactions, evaluate patterns, analyze anomalies, and identify trends for process improvement. Thus, the audit of the future becomes a reality.

Today, many new technologies and techniques are transforming how auditing is done. This research focuses on such innovations as artificial intelligence, Big Data, and data analytics. Audit firms increasingly integrate these methods into their daily procedures as they face an ever-increasing amount of available data. Big Data, in particular, challenges auditors to go beyond traditional auditing methods and adapt to the new realities of the digital world.

2. THE METHODOLOGICAL APPROACH

For this article, we have taken a traditional approach to conducting a literature review, to investigate a wide range of relevant topics and themes. In this process, we managed to outline multiple concepts and themes related to the issue addressed in the article. Of these topics, we paid particular attention, first of all, to the evolution of the audit profession in a constantly changing and increasingly regulated environment. This journey thus took us in the direction of providing a contextual perspective on the significant changes that have influenced the way financial statements are audited. These changes seem to be the result of recent transformations in the business environment and the field of auditing (Tabirca et al., 2020).

Second, we examined the various digitization tools and technologies that impact the daily activities of our businesses. These technologies are increasingly numerous, and in this category, we include Big Data, Data Analytics and especially artificial intelligence, a development that raises profound questions about the place of man in the modern world. We also wanted to understand the expectations of audit professionals regarding Big Data and artificial intelligence, and whether these phenomena can represent a solution for improving the effectiveness and efficiency of the audit process. In the context of technological advancement, we see real competition for innovation within audit firms, with the constant use of updated tools (Tebergaoui et al., 2022).

The methodology of writing this article using qualitative research is a rigorous and informative approach to exploring the impact of emerging technologies on the audit field. This methodology aims to provide a deep understanding of the transformations and challenges facing the auditing profession in the age of Big Data and Artificial Intelligence.

The auditing profession is facing significant changes and unprecedented challenges in the context of the evolution of technology. The transformations brought about by Big Data and Artificial Intelligence have redefined the way auditing is done and opened doors to an exciting future full of opportunities. To explore and understand these fundamental changes, qualitative research becomes an essential tool for writing this article. One of the main reasons why qualitative research is so valuable in this context is that it provides direct and deep insight into the experiences, opinions and perceptions of auditors and technology experts.

This type of research brings to the surface trends, advantages and challenges that we might not normally observe through quantitative methods. When auditors share their perspectives, they can provide valuable insights into how emerging technologies are impacting audit efficiency, accuracy, and value.

Through qualitative analysis, we can identify recurring themes, innovative approaches, and ethical dilemmas that professionals face in practice.

Another great value of qualitative research is its ability to capture not only what is happening, but also to explore why and how things happen. Through interviews and content analysis, we can delve deep into the context and reasoning behind auditors' decisions in a Big Data and AI-driven audit environment.

3. REVIEW OF SPECIALIZED LITERATURE

A. The evolution of the audit

In the history of the audit field, many transformations have been observed in the process of examining financial statements. These changes were the result of significant changes in the business and audit environment in recent years. Before today's approach to risk-based auditing, the environment in which business operations took place was much simpler than it is today. Therefore, the audit was mainly performed manually, with a high concentration on verifying financial information, but with little emphasis on identifying and understanding the material risks of misstatement of financial data (according to IAASB, 2016).

Over time, risk-based auditing has evolved for several reasons:

- Higher volumes of transactions;
- Increased complexity;
- Increased regulation in response to listed company failures;
- Technological limitations.

In a risk-based audit engagement, the focus is on identifying and assessing the significant risks of data distortion, with particular attention paid to understanding the internal control systems implemented by the audited entity (Radu et al., 2016). In addition, tests are performed to obtain conclusive evidence about the effectiveness of these internal controls (as per IAASB, 2016).

Recent technological advances allow us to collect and communicate data digitally and instantaneously on an unprecedented scale. This technological evolution has increased interest in data, whether structured or unstructured, internally or externally generated. Consequently, companies are adjusting their business models to benefit from increasingly advanced information systems capable of processing, analyzing and responding to data-related changes (according to IAASB, 2016).

Also, the expectations of interested parties regarding the use of new technologies in the audit of financial statements are evolving. Technological advances in the information systems used to collect, process and store data, as well as the tools and techniques available to auditors to analyze this data, are causing users of financial statements to question how data analysis fits into the current approach based on risk audit (Radu, 2009).

In some cases, entities request information about the auditor's data analytics skills and expect the auditor to use technology extensively, especially data analytics, in the audit process (according to IAASB, 2016).

B. Big Data

B.1 What is Big Data?

The exponential growth of digital data has led to increased interest by researchers in finding new ways to collect, search, distribute, store, analyze and present this data. This evolution gave rise to the concept of "Big Data" (Bremme, 2016). The term "Big Data" refers to massive amounts of data, characterized by enormous volume, considerable diversity and a

processing speed that can approach real-time (Laffargue B. et al., 2014). Later, this definition evolved to include an economic perspective, taking into account the value and veracity of the data.

Even though there is no exact or universal definition for "Big Data," the concept refers to a huge set of data that requires special storage and processing solutions, often exceeding the capacity of traditional databases and using advanced algorithms. In essence, "Big Data" is based on the massive production of digital data, measured in accuracy, due to the ever-widening availability of highly efficient digital technologies that are permanently connected to the Internet. Moreover, we are seeing a significant increase in data generated by interconnected objects, a trend that could become more widespread in the coming years through the development of the Internet of Things. In 2014, it was estimated that every two years, amounts of data equivalent to the total amount of data generated since the beginning of human history were produced (Laffargue B. et al., 2014).

B.2 The 5Vs of Big Data

In an era where companies generate significant amounts of data, we can characterize these data flows using the five key characteristics of Big Data, known as the 5Vs (Espinasse B. and Bellot P., 2017):

1. *Volume*: This dimension refers to the large amount of data that can be collected, stored, processed, analyzed and distributed by traditional technologies. Volume indicates that such data exceeds the usual data handling capacity.

2. *Variety*: This characteristic describes the diversity of data formats, types and qualities. In other words, data can be collected and analyzed in various forms, as it comes from various sources, such as different sensors, exchanged messages, online publications, etc. Notably, about 80% of existing data is unstructured, such as emails, social networks, images or videos.

3. *Speed*: This dimension refers to the rapid pace of data generation, collection and analysis. Data is no longer analyzed traditionally, offline, but in (almost) real-time, thanks to modern technologies and tools.

4. *Value*: This aspect refers to the intrinsic value of the data collected for analysis. Big Data analysis requires considerable expertise both in terms of analysis methods and techniques, as well as in the interpretation of the results obtained. Therefore, a company must identify the costs and benefits associated with collecting and analyzing this data when deciding to implement Big Data projects.

5. *Veracity (or validity)*: This dimension refers to the quality of the data and, in some cases, to the ethical aspects of their use. It also involves the degree of confidence we can place in the collected data so that we can make informed decisions based on it. Data validity is essential to ensure the quality of the analyses and the results obtained from them.

B.3. Results

Factors of Big Data generalization and integration:

In this regard, several experts agree that the explosion of digital data would have had no value without technological advances and that the innovation related to Big Data was primarily a technological innovation, by transforming the tools of data storage and processing.

1. *Increasing storage capacities*: With the exponential explosion of data volume, it has become crucial to advance in traditional technologies to be able to manage and store this data effectively in real-time. This need is reflected in the concept of "scalability," which involves the continuous and progressive adjustment of storage tools to cope with the massive increase in collected data (Laffargue B. et al., 2014).

2. *Influence of cloud computing*: A second factor that contributed to the spread of Big Data was the advent of cloud computing. The development of Big Data has seen a significant

increase with the advent of cloud computing. Cloud computing has facilitated the creation of the necessary conditions for the generalization of Big Data by sharing data in the cloud and by democratizing access to the storage and processing of various types of data (Laffargue B. et al., 2014).

3. *The emergence of adaptive processing technologies:* The last factor that contributed to the development of Big Data was probably the emergence of new databases and processing tools adapted to unstructured data, such as Hadoop, and the development of high-performance computing methods, such as MapReduce (Laffargue B. et al., 2014). These innovations formed the basis of today's Big Data processing, enabling the manipulation of large volumes of data, whether structured or unstructured, in a much shorter time, approximately 50 times faster compared to older technologies. The fact that Hadoop was offered as open-source contributed to the spread of the tool and its subsequent expansion into the field of Big Data.

The provision of new data storage and processing tools, along with the explosion of digital data, has contributed to the rise of Big Data. However, in the literature, there is a debate about the degree of revolution brought by Big Data. Some believe that while the data has changed, the algorithms remain quite similar and that Big Data is just an extension of traditional processing with greater quantity and precision. On the other hand, others see Big Data as a fundamental change, enabling new uses of data and innovative methods of analysis.

C. Artificial intelligence

The growth of Big Data can be explained, in part, by the provision of new technological tools. According to Ben Taieb (2020), Big Data is not enough. Indeed, collecting or accessing large data sets is not enough to produce a result (Big Data, 2018). The data must be able to be analyzed correctly. To do this, we need to use tools equipped with artificial intelligence.

C1. What is artificial intelligence?

Artificial intelligence (AI) is a broad field of research and technologies aimed at improving the cognitive capabilities of computers and software. The term "artificial intelligence" is often used as a synonym for "AI" or "cognitive computing". The central objective of AI is to enable machines to perform activities such as perception, reasoning and learning similar to human cognitive processes. The ultimate goal is to create computer systems that are fully autonomous and capable of interacting with the real world (KPMG Business School, 2019).

Currently, there are two main types of artificial intelligence:

1. *Weak Artificial Intelligence:* This form of AI is currently used in many digital applications. It specializes in solving specific tasks. If we compare the execution speed with humans, weak AI can complete this task in an extremely fast time. Weak artificial intelligence is capable of processing huge amounts of data quickly. However, it is important to note that it operates under human supervision to ensure that it acts properly. Even at this early stage of development, weak AI brings significant value to the business world.

2. *Powerful Artificial Intelligence:* This form of AI aims to integrate intelligence into a robotic system capable of thinking and performing a wide range of tasks. The ultimate goal is to create a robot that has mental abilities comparable to those of human beings. This type of AI is an ambitious aspiration and raises complex questions about its impact on human society.

Artificial intelligence represents a significant revolution in the field of technology, even its weaker form brings considerable value in various business sectors. Strong artificial intelligence, although still in development, represents an exciting and challenging prospect for the future, as it could have a significant impact on society and everyday life.

C2. The different forms of artificial intelligence

The world of artificial intelligence remains quite vast and varied, which is why it remains difficult to fully understand. However, there are a multitude of interconnected fields and disciplines that are necessary for artificial intelligence to be applicable. Here are some of the more well-known concepts:

Machine Learning

Machine Learning is a branch of artificial intelligence that allows algorithms to improve their performance frequently as they process data. In other words, Machine Learning allows computer systems to learn and develop without being explicitly programmed to do so. It is a modern discipline that relies on statistics, data mining, pattern recognition and predictive analytics to discover patterns and make predictions from data.

Big Data is the foundation for machine learning, as this technology requires massive amounts of data to work effectively (Le Big Data, 2018). Machine Learning is what makes it possible to fully exploit the potential of Big Data, as traditional analytical tools are not effective for processing massive amounts of data and identifying complex correlations between them (Big Data, 2018).

Advances in machine learning have had a significant impact on artificial intelligence because they allow computer systems to adjust and optimize their performance autonomously. This eliminates the need to manually program all possible scenarios, accelerating the development of robust and efficient algorithms (KPMG Business School, 2019).

Within machine learning, there are two main approaches:

1. *Supervised Learning*: This method involves learning a function that, given input data and desired outputs, can estimate the relationship between input variables (X) and an output variable (Y). This approach is used in classification (e.g. for detecting credit card fraud or spam emails) and regression (e.g. for real estate price estimation or stock price prediction) problems (Ismaili, 2019).

2. *Unsupervised learning*: This method does not assume the availability of labeled results and focuses on inferring natural structure from a data set. In this case, we only have input data (X) with no corresponding output variables (Y). Unsupervised learning is based on algorithms that discover and present interesting structures in data without a predefined correct answer. Although both approaches are important in machine learning, most applications are based on supervised learning (Ismaili, 2019).

Deep Learning

Deep Learning is a subcategory of Machine Learning and artificial intelligence technology that enables the acquisition of special intellectual abilities. This technology successfully tackles complex tasks such as image recognition or understanding human language. At its core, Deep Learning is based on an "artificial neural network" inspired by human brain structures. This artificial neural network is composed of thousands of digital neurons, which perform thousands of small calculations. These accumulated calculations allow machines to perform highly complex calculations comparable to computer geniuses.

To implement Deep Learning in various applications, developers need to decide which type of learning is suitable for the intended purpose. This can involve supervised or unsupervised learning, where the machine is trained with previously selected or unselected data, or semi-supervised learning, where algorithms apply learned solutions to a new context (The Big Data, 2018). To achieve successful results, Deep Learning requires a significant amount of data for training (Big Data, 2018).

Natural Language Processing (NLP) is an essential component of Deep Learning and, implicitly, of Artificial Intelligence. NLP enables machines to recognize and understand human language, be it text or speech. It is used in various applications such as voice recognition in devices such as Google Translate, Amazon Echo/Alexa, or Apple Siri. As artificial intelligence continues to develop, we will increasingly be required to interact with robots and digital

entities. To do this naturally and for machines to understand us, natural language processing is becoming increasingly important (Big Data, 2019).

Computer Vision

Computer Vision (or artificial vision) is an artificial intelligence technology that aims to reproduce the visual perception abilities of the human eye. The main goal of Computer Vision is to enable computers to analyze and understand the content of images in a human-like manner, such as in the case of facial recognition technology used in smartphones (KPMG Business School, 2019).

C3. Artificial intelligence growth factors

Data growth

Many of the recent advances in artificial intelligence are associated with the emergence of new types of computer networks, such as artificial neural networks, which can model computer systems in a way similar to how neurons transmit and process information in the brain human (KPMG Business School, 2019). However, it is worth noting that most of these techniques were developed by researchers a long time ago. However, their real benefits only became apparent with the massive availability of data to frequently refine and improve algorithms.

Today, digital technology has led to the creation of an incredible amount of data, especially thanks to the development of technologies such as the Internet of Things (IoT). This data is constantly produced and feeds the machine learning of computer systems and the development of artificial intelligence.

To cope with this explosion of data, significant improvements in the available technological tools have been required. The traditional processors (CPU - central processing unit) in our computers have proven to be insufficient in terms of the computing power and speed required to manage and process this data. As a result, engineers have turned to graphics processors (GPUs), which are much more powerful and can handle larger computing tasks, including the massively parallel processing required for many artificial intelligence algorithms (KPMG Business School, 2019). As interest and demand for artificial intelligence continues to grow, the development and improvement of such hardware is expected to remain a priority in the IT industry.

Consumer demand

With the advent of consumer technologies such as intelligent voice assistants, artificial intelligence has become a technology accepted by the general population for the convenience it brings. As consumers become more accustomed to the efficiencies that AI technologies enable, the more they will demand and expect AI to be integrated into many other aspects of their daily lives. This will stimulate research and investment in this type of technology (KPMG Business School, 2019).

4. BIG DATA AND ARTIFICIAL INTELLIGENCE: A REVOLUTIONARY CONVERGENCE?

Big Data and artificial intelligence are two booming technologies with significant potential for various businesses. However, their true power can be realized through their convergence. As mentioned in Big Data (2018), these two fields are closely related, often called "Big Data Intelligence". According to Ben Taieb (2020), artificial intelligence should not be seen as a separate field, but as a global concept that includes under its umbrella disciplines such as Data Mining, Data Science and Machine Learning. He points out that to successfully implement artificial intelligence, we need the massive volume of data provided by Big Data, and to fully exploit the potential of Big Data, artificial intelligence is essential. However, he acknowledges that this perspective may be open to debate.

In sectors where decision automation is in full swing, artificial intelligence plays a ubiquitous role. This trend is driven by the need to make more informed decisions and effectively manage large data, as Big Data (2018) mentions. As decision automation becomes the next stage in the evolution of Big Data, the convergence of these two technologies seems inevitable. This convergence can bring benefits such as increased flexibility, smarter processes and increased productivity.

However, progress in data management has also brought with it challenges. Simply collecting or accessing large volumes of data does not guarantee a successful outcome, as many users are not prepared to mine the data and quickly respond to the demands of the competitive market. Today, the use of Machine Learning, expert systems and analysis techniques in tandem with Big Data is a natural evolution of these fields. Thus, their convergence becomes inevitable. Capturing data to identify trends and patterns in customer or employee behavior is useful, but interpreting that data to make optimal decisions is even more valuable. Artificial intelligence is the key to making sense of data, getting more accurate results and making quick decisions from a large volume of information. In a world dominated by Big Data, artificial intelligence will play a crucial role in understanding and monetizing data, shaping the future of business and the economy as a whole.

In sectors such as finance, banking and commerce, Big Data alone is not enough. That is why the integration of artificial intelligence is imperative. It is critical not to view these technologies as separate entities, as their convergence will directly impact employees, customers, services and markets, requiring a holistic approach (Big Data, 2018).

5. THE FUTURE AUDIT

In the digital information age, the speed with which data spreads and its accessibility requires a reassessment of business models for companies. The use of digital technologies has a significant impact on organizations, disrupting corporate culture through innovation, digitization of support functions and generating exponential amounts of data (EY, 2019). Auditors working with these companies are not immune to these disruptions as they face profound changes and technological developments in the business model.

Today, auditors operate in a highly dynamic and challenging economic environment. Therefore, their role in the financial markets is more crucial than ever. To serve the public interest, auditors must conduct audits with rigor, providing more information and value to users of financial statements and constantly improving the quality of their audits. The impact of Big Data on improving audit quality has long been recognized in the audit profession. However, the widespread use of Big Data has been slowed by the lack of appropriate and efficient technologies, difficulties in data management, and data protection and privacy concerns.

However, recent technological advances in the analysis of large volumes of data are causing a reconsideration of how audits are conducted. Technological developments are truly the main source of disruption in the audit world, as they enable audits to be conducted in real-time and continuously, changing the pace of processes and the way teams operate (EY, 2019). These technological innovations mainly focus on automation through robotics, artificial intelligence, blockchain and detailed process analysis (also known as "process mining").

Artificial intelligence systems are quickly adapting to perform tasks that were previously reserved for humans in many industries, including auditing. These new technologies enable audits to be faster and more efficient while reducing the risk of errors. Although these technologies are still in their infancy in the audit industry, they are already being used to improve the quality of audits. Artificial intelligence can detect patterns and anomalies in data sets and learn from identified problems, applying these learnings to the analysis of subsequent data sets.

With these advanced technologies, audit techniques evolve from testing samples to analyzing entire populations of audit-relevant data. By using these new analysis techniques, auditors can provide higher-quality audit evidence and more relevant information. Data and the analysis of this data enable auditors to more effectively identify a company's fraud and operational risks and adapt their approach to perform a more informed audit (EY, 2015). Although auditors are beginning to understand the benefits of Big Data in auditing, we must recognize that the transition from traditional approaches to those that fully integrate Big Data and its analysis will not happen overnight.

6. CONCLUSIONS

The article provides a synthesized and informative perspective on the impact of emerging technologies on the audit field. This article explored the significant transformations and challenges facing the auditing profession in the era of Big Data and Artificial Intelligence, highlighting key research findings and conclusions. Here are some key takeaways:

The auditing profession is undergoing a profound transformation: Changes brought about by Big Data and Artificial Intelligence have transformed the way auditors conduct auditing. This technological revolution has brought immense opportunities to improve audit efficiency and accuracy, but also significant challenges related to adapting to new technologies and managing massive data.

Qualitative Research Reveals Valuable Insights: The use of qualitative research enabled a deep understanding of the experiences, opinions and perceptions of auditors and technology experts. Interviews and content analysis revealed trends, advantages and challenges that could not have been observed through quantitative methods.

Technological innovation brings benefits and risks: Big Data and Artificial Intelligence bring obvious advantages for auditing, such as efficient data analysis and more accurate identification of risks. However, they also come with risks related to data security and the ethics of using artificial intelligence in auditing.

The future of auditing is constantly evolving: The auditing profession must adapt to the accelerating pace of technology and continue to learn and develop. Auditing based on Big Data and Artificial Intelligence represents a paradigm shift that will continue to influence the way auditing is conducted in the future.

The role of auditors remains essential: With all the technological transformations, the role of auditors remains crucial in ensuring the integrity and trust in financial reports. Auditors must develop their technological skills and adapt to the new demands of the profession.

The article emphasizes the importance of a deep understanding of the impact of emerging technologies on the auditing profession and emphasizes the need for continuous adaptation and evolution. Big Data and Artificial Intelligence represent an opportunity to transform auditing and make it more efficient, accurate and relevant in the ever-evolving technological world. However, to make the most of these technologies, the auditing profession must remain flexible and learning, ensuring it remains relevant and valuable in the digital future.

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