International Journal of Business Innovation

# The Implications of Industry 4.0 for the Auditing Profession

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**Received**: February 26, 2022; **Accepted**: March 28, 2022; **Published**: March 31, 2022.

**Citation**: Tavares, M. C.., Zimba, L. N., & Azevedo, G. (2022). The Implications of Industry 4.0 for the Auditing Profession. *International Journal of Business Innovation*. *1*(1), e27625. https://doi.org/10.34624/ijbi.v1i1.27625

**Abstract:** The technological development resulting from Industry 4.0 is also affecting the auditing profession. If on the one hand the new technological components of Industry 4.0 demonstrate how their implementation can facilitate the auditor's work and improve the decision-making process in business management, on the other hand they require new skills and knowledge to the professional exercise

Thus, the objective of this study in a real work context - fieldwork - is to analyze the impact of the new technologies of Industry 4.0 in the Auditing profession. With this work, it was possible to understand that the digital transformation and the use of the new technologies provided by Industry 4.0, besides serving as an aid to management and to the auditing professional, do not replace man, in his social, sentimental, and thought relations, crucial aspects for the profession of Auditor.

**Keywords:** Audit Profession; Audit 4.0; Auditing; Industry 4.0; New Technologies.

## 1 Introduction

Technology has profoundly influenced the evolution of the audit profession. The technologies developed with Industry 4.0 (I4.0), such as Blockchain, big data, Internet of Services (IoS), among others, will drastically change the current business model and society in general, so companies must adapt to this rapid change in the current environment.

The current scenario, social and economic, has shown itself to be increasingly dependent on information technologies, not only for the various facilities they provide, but also for the dynamization of processes, such as the reduction of human intervention in such processes. Nevertheless, although these technologies entail high implementation and maintenance costs, they reduce the risk of human error, as well as fraudulent data manipulation, which can be more costly to companies than these technologies, because the magnitude of the error or fraud cannot be immediately measured exactly. While there are technological advances, ignorance, or lack of mastery of the technologies can limit their scope and application in today's world. It is crucial that a new social posture is created, focused on the importance of Information Technology (IT), as well as the digitalization of processes.

According to Schwab (2016) we are all responsible for following this evolution, whether in the decisions we make in our daily lives as citizens, or as consumers and investors, towards I4.0. These developments force the monitoring and integration of Information and Communication Technologies (ICT), making them an integral part of organizations and professions including the profession of Auditor (Almeida & Carvalho, 2020). In this context, I4.0 seeks to improve the processes of value creation for the organization, using automation and data storage, through new technological components that allow companies that have a digital structure to improve and support all their activity. We must seize the opportunity and the power we must shape the fourth industrial revolution and direct it toward a future that reflects our common goals and values (Schwab, 2016).

It is also important to mention that the technological development in Big Data Analytics, Artificial Intelligence (AI) and Blockchain have influenced Accounting and Auditing, areas that, as an example, have directly and continuously benefited from these advantages. For, in addition to having automated processes, it also has tools capable of examining and evaluating complex entity data in a short period of time. In this vein, according to Mancini (2016), in addition to the impact on Audit, this development also serves as a management aid. It has tools that can be useful in defining the entity's internal controls, as well as in improving decision-making processes in a timely manner.

During a fieldwork, in a real work context in the Auditor's profession, the impact and challenges of new I4.0 technologies in the Auditor's profession will be analysed, accompanied by a literature review. For, as Asif et al. (2022) point out, previous studies mainly discuss the application of some technologies in auditing, with an emphasis on financial auditing, and do not explore the underlying technologies of I4.0.

With this work, which contributes to the literature for both academics and audit professionals. it was possible to understand that digital transformation and the use of new technologies provided by Industry 4.0, besides serving as an aid to management and the audit professional, do not replace man, for his intrinsic characteristics of being-human, in the auditing profession.

This study is structured into two main sections, in addition to the introduction and concluding remarks. These sections comprise a literature review on the importance of I4.0 in digitization processes and the alignment of I4.0 with auditing and the audit profession.

## 2 Industry 4.0 in Digitization Processes

The concept of I4.0 was introduced in 2011 at the Hannover Fair by the German government in its "High-Tech Plan 2020", often known as "Smart factory". This concept is defined as the technological development of embedded systems for smart Cyber-Physical Systems (SCF) that occurred in industry (Hamid et al., 2022). Lin et al. (2018) argues that I4.0 can be understood as a combination and integration of digital technologies, such as advanced robotics, AI, sensors, cloud computing, Internet of Things (IoT), big data analytics and classification, additive manufacturing, and mobile devices, among other digital technologies, into an interoperable and shareable global value chain, regardless of geographic location. Gallab et al. (2021) consider that this concept refers to this new generation that seeks to solve and deal with the complexity of productive systems and a new form of organization. Thus, I4.0 can be understood as a revolution that enables the application of advanced technologies in top production to bring new values and services to customers and the organization itself (Khan & Turowski, 2016).

In this sense, we may be entering a new world where computers and automation come together in a whole new way, with robotics connected remotely on computer systems equipped, with intelligent machine algorithms, can control robotics with minimal human support (Chouhan et al., 2017). Looking across the broad family of I4.0 technologies, one can anticipate a new paradigm at scale, where organizations can grow rapidly without encountering many of the constraints or challenges that some traditional enterprises face (Chalmers et al., 2021).

According to Tavares and Azevedo (2021) I.40 can be perceived as a natural transformation of industrial production where systems are triggered by the trend of current digitalization. Thus, the concept of I4.0 can be understood as the growth of digitalization in the middle of production, where physical structures are more aligned with digital information networks, allowing for greater integration of many systems at all levels of production, enabling more practical solutions with fewer possible operations (Maslarić et al., 2016). One of the biggest results of the implementation of digitization is related to the increased efficiency and productivity of production processes, having the possibility to oversee in a more automated way the whole process, allowing the company to efficiently allocate its resources (Carmona, 2017). I4.0 is focused on the digitalization of physical assets and their integration into digital ecosystems with various value chain partners (PWC, 2016).

The goal of I4.0 is to increase the flexibility of the existing value chain by maximizing the transparency of inbound and outbound logistics, production, marketing, and all other business areas in the entity, such as accounting, legal, human resources, among others (Dai, 2017). Gallab et al. (2021), in their study, identified that the major benefits of applying this technology in organizations are: improving product quality; improving decision-making; reducing operating costs and increasing productivity; saving natural resources; new skills; reducing the number of errors; and improving product customization. As disadvantages, implementation requires high costs; and limited corporate structure and culture.

However, the technology component of I4.0 is being adopted around the world and can influence other corporate initiatives and efforts. In general, there are nine main technology components that make up the foundation of I4.0: autonomous robots, big data, Augmented Reality (AR), Additive Manufacturing (AF), cloud computing, cybersecurity, IoS, system integration, and simulation (Chouhan et al., 2017).

In this context, autonomous robots comprise the autonomous production methods driven by robots that can complement tasks in an intelligent way, with a focus on safety, flexibility, versatility, and collaboration, where their integration into human workspace becomes more economical and productive (Bahrin et al., 2016). According to the same authors, in I4.0, robots and humans will work side by side, in interconnected tasks using intelligent sensor human-machine interfaces. The adoption of IoT technologies, big data and cloud computing, has led to better value creation for both the customer and the enterprise (Ranjan & Foropon, 2021).

New technologies in big data and analytics, enable the broad collection and evaluation of data, from different data sources and customers, to support timely decision making, optimizing the quality of production (Brown-Liburd & Vasarhelyi, 2015). These can enable new capabilities and organizational value (Davenport et al., 2012). They provide organizations the ability to visualize situations that they would not otherwise be able to see. Considering the emergence of such tools, organizations will use larger and more diverse data sets to identify impacts, insights, and inconsistencies throughout service delivery (Ranjan & Foropon, 2021).

According to Posada et al. (2015), AR is the bridge between virtual and physical objects, and the devices that enable it to make it possible to enhance human perception by providing information in a more intuitive and effective way.

FA, on the other hand, is a 3D printing technology through which it is possible to obtain resistant parts, patterns, and models. Using this technology allows the product development cycle to be shortened to actual market launch and reduces waste, resulting in more efficient processes (Cotteleer & Joyce, 2014). Organizations have seen a major shift in the use of cloud solutions, and this will continue to grow. Continued advances in technology, machine data and its functionality will continue to shift to cloud solutions.

According to Chouhan et al. (2017), cloud computing enables much faster deployment of upgrades, performance models, and delivery options compared to a standalone system.

SCFs are represented by online networks of analogous equipment that are organized similarly to social networks, connecting IT with mechanical and electronic elements that communicate with each other through the network (Dai & Vasarhelyi, 2016). For Lee et al. (2015) SCFs can be considered as the integration of computing with physical processes, meaning that these systems enable a world where physical and virtual spaces are interconnected, allowing a better interaction between both realities.

IoT is the common term within the I4.0 landscape and refers to the ability of any physical object to communicate with the internet, enabling the sending and receiving of data. It is understood as a network of connected things and refers to an ecosystem composed of connected objects, applications, or services (Hamid et al., 2022). IoT uses IT to unite all internal, external processes, subsystems, suppliers, and customers so that information passes through the entire value chain, forming a larger database and cloud computing (Maslarić et al., 2016).

IoS is the ability for services to be delivered through digital platforms using the internet. This type of technology has caused major changes in some business models, offering a more direct, fast, effective, and intuitive contact of the customer with the

company, without the need to travel (Dai & Vasarhelyi, 2016). According to Maslarić et al. (2016) I.40 enables people and smart factories to be able to connect and exchange information through IoT and IoS, enabling the connection of physical systems with cyber-physical models and decentralizing decision making, increasing the ability to adjust to market requirements in real time and independently.

According to PWC (2016), I4.0 is driving the digitization and integration of vertical processes across the organization, from product creation and purchasing, to manufacturing, logistics, and services. By offering disruptive digital solutions, such as data-driven services and integrated platform solutions, companies can diversify their offerings, becoming more competitive and efficient.

The adoption of IoT, big data, and cloud computing technologies has led to better value creation for both the customer and the company (Ranjan & Foropon, 2021). For auditors, these technologies provide a broader view of financial processes to visualize business strategies and business models or processes that can be improved (Cristea, 2021). All information generated, regarding operational processes, quality management, efficiency, as well as operational planning, is available in real time, and these are one of the benefits that I4.0 provides (PWC, 2016).

Technological advances have had a great impact on information systems, bringing about changes in the operational and management processes of organizations, especially in the way financial information is handled (Betti & Sarens, 2021).

## 3 Industry 4.0 Alignment and Auditing

Traditional manual audits (Audit 1.0) have been around for centuries and meet many needs. IT auditing (Audit 2.0) emerged in the 1970s, where most companies already had computers, and where auditing moved from a manual to an automated process. It is debatable whether Audit 3.0 emerged much faster than the previous generations, as it may be impossible to ensure the development of systems such as Big Data with the tools used in the past (Dai & Vasarhelyi, 2016). The key characteristics of these audit generations are shown in Table 1.

**Table 1.** Generations of auditing (adapted from Dai (2017))

| Auditing 1.0 | Auditing 2.0 | Auditing 3.0 | Auditing 4.0 |
|---|---|---|---|
| Manual Audit | | Big Data Inclusion in Auditing | Audit Automation |
| Tools: pencil and paper | Auditing and IT Tools: Excel, CAAT Software | Analytical Tools: Analytical Apps | Tools: Sensors, SFC, IoT/IoS, RFID GPS. |

Disruption brings with it much more automated and technologically complex processes. The industry is moving into the so-called "new generation", and it is of utmost importance that auditing keeps pace and adapts to this environment. The increasing technological needs of management force the accounting methods used to adapt to these needs. In turn, they put pressure on the entity's environment to adjust and with greater assurance to the level of evaluation and validation of the information that is provided (Krahel & Titera, 2015). For example, the adoption of database and cloud technology has led to the development of software and applications for measuring the economic performance

of organizations, leading naturally to the need for auditors to certify whether there are risks of the information being materially distorted.

According to Tekbas (2018), the accounting profession is beginning to appreciate the progress, technology-driven, largely because of the speed and quality it offers. It therefore requires reliable, detailed and error-free processes that feed organizations with the appropriate and necessary information to make correct and appropriate decisions about their future. The processes and results can only be offered with cutting-edge technology, such as those offered by artificial intelligence, blockchain and big data analytics, etc., (Nwachukwu et al., 2020). These technologies come to improve the audit processes and the quality of the final work delivered by analyzing and understanding the risks that the company faces, i.e., where control has the most deficiencies (Cristea, 2021).

Auditing will benefit from the technology promoted by I4.0, especially IoT, IoS, SCF and "Smart Factories" to obtain financial and operational information as well as other audit-related data from an organization and related parties. These tools drive more integrated data analysis, anomaly identification, and extraction of other useful information to provide efficiency and effectiveness to the auditor's work (Dai & Vasarhelyi, 2016). Their use has caused the auditor's effort to reduce, from information analysis to calculation. These authors argue that auditing will be an overlay of I4.0 business management processes.

For example, given the speed with which audit work can be done, a single auditor can complete several audit tasks in a short period of time (Nwachukwu et al., 2020). As such, there would be no need to hire new ones. The implication here is that practical experience will eventually be lacking in many new auditors. Thus, many companies are to some extent changing recruitment policies by placing greater emphasis on digital skills over financial skills when hiring new workers. However, the shortage of necessary skills means that some audit departments are currently forced to outsource certain digital-related activities. These barriers to using these tools emphasize the need for digital skills acquisition to understand how new technologies work and their potential impact on audit functions (Betti & Sarens, 2021).

The emergence of these technologies has brought organizations a very different set of business processes that support the modern business organization and provide entirely new tools. As such, the traditional view of audit evidence may not be sufficient, and the audit profession and regulators should be aware of the impact that a more advanced technological environment is likely to have on certain traditional forms of audit evidence collection (Brown-Liburd & Vasarhelyi 2015).

In 1998, Manson et al. stated that the most important benefit of automation in auditing was the improvement in audit quality and the most important costs were those of staff training and learning time. Therefore, I4.0 technologies can help establish continuous and real-time audits, which facilitates the emergence of a new audit generation, Audit 4.0, that will affect the auditing profession (Elommal & Manita, 2022).

### 3.1 Auditing 4.0 and its Impact on the Profession

The use of new technologies in the Audit profession helps increase the accuracy of analysis due to their ability to: test complete data sets rather than limited samples; generate more accurate fact-based conclusions; automate the process and increase efficiency levels;

and offer predictive analytics in addition to examining historical information (Betti & Sarens, 2021).

With the advent of distributed accounting technology, auditing will have a revolution in the profession as auditors check all scanned documents instead of checking a sample of physical documents during the audit (Antoney & Augusthy, 2019). While companies expect innovation from auditors, auditors should be careful about rushing to use new technology that they are unfamiliar with (Nwachukwu et al., 2020). The auditor of the future should be someone technologically savvy, with a conception of the impacts of ICT and how the market develops, to be able to adapt to technological developments and thus continue to be an integral and determining part, of a market that will be increasingly competitive (Almeida & Carvalho, 2020).

There are significant challenges for the profession (Elommal & Manita, 2022) and the skills required to be a full auditor will change dramatically soon (Karapinar, 2021). While on the one hand, auditors must broaden their technology skills and knowledge and be able to anticipate and respond to their clients' demands, on the other hand, audit firms must invest in recruiting technology skills and adapt their internal organization to a culture of innovation and client satisfaction to establish their continuous audit offering (Elommal & Manita, 2022).

The evolution of the "modern" auditing profession has been driven by the development of technology in recent decades, and it can be said that we are moving towards "Audit 4.0", according to (Dai, 2017). According to Dai and Vasarhelyi, (2016) "Audit 4.0" impacts the audit profession from 4 perspectives: standards, principles, technology, and auditors.

Patterns can be programmed into machines and production lines to allow inventories to be measured and processed and counted in real time to gather relevant information for auditing (Dai, 2017). Inventory measurement can be automated by tracking purchase prices (Krahel & Titera, 2015). In addition, products will autonomously emit signals in case they are obsolete or damaged, to avoid adding or increasing the value of obsolete inventory. Such automation can reduce auditor effort by reducing exhaustive physical verification and additionally provide accurate performance and risk information in real time (Dai & Vasarhelyi, 2016).

For Dai (2017) I4.0 consists of 6 main principles: interoperability, digitalization, decentralization, real-time capability, service orientation, and modularity. Therefore, "Audit 4.0" relies on these principles to increase data availability, enable data to be monitored and validated continuously, and improve the automation of audit procedures.

In I4.0, field devices, machines, plants, factories, and even products will all be connected and communicate through a global network, which enables interoperation within companies and across value chains (Drath & Horch, 2014). Through the communication enabled by interoperability, new business models can become more intelligent and informative and achieve a higher level of optimization. As interoperability the current business model continues to change, which may further impact the auditing profession. Thus, in "Audit 4.0" the interoperation between suppliers, customers, banks, and other business entities can allow transactions to occur in near real-time, where a secure network

is established to facilitate communications between different business entities to ensure the occurrence and integrity of information (Dai & Vasarhelyi, 2016).

For example, if any transaction involves two entities, the two systems, such as Enterprise Resource Planning (ERP), will share the accounting information that links the transaction and the entity. The entity will receive the information and match it with the database corresponding to the transaction in question in the system and the auditors can already be aware of the occurrence of some anomaly, if after joining the data they are not connected.

Today, audit firms are going digital, deepening their knowledge to exploit new trends in big data and new digital tools to add value to clients. Digitalization is one of the key drivers of I4.0, as it enables companies to benefit from efficiencies in all aspects, from management consulting and technology to strategy and supply chain solutions (Javaid et al., 2021). For in I4.0, as objects are connected to networks, information about location, conditions, and surrounding environment can be shared and integrated into the network and become searchable, exploitable, and analysable (Drath & Horch, 2014).

Digitalization enables transparency across the entire value chain, with all business processes and their performance is presented in a detailed manner (Schuh et al., 2014). Therefore, audit activities are at a crossroads and companies must change their approaches. Digitalization changes the way audits are carried out, and thus they should integrate digital technologies into their future strategies (Manita et al., 2020). According to the same authors, digitalization highlights the need for constant changes in audit functions to provide more detailed and robust analysis to clients. This digitalization can increase audit quality and satisfy shareholders and other related parties by making the auditor's work and shared information more relevant, using digital tools such as big data analysis. The auditor can evaluate all data from the audited company without the need to use the "sample" method. In fact, digitalization in the audit processes allows him to improve risk assessment and the quality of judgments by identifying all anomalies and recommending solutions to the issues highlighted. Finally, the audit can also focus on current data, not just historical information, to give a forward-looking view of the sustainability of the audited company by assessing the current level of sales. This additional analysis can significantly reduce the opportunistic behaviors of managers and thus improve audit relevance and corporate governance (Manita et al., 2020).

The management of organizations' resources is increasingly dependent on cloud systems with virtual machines. Soon, these systems will extend into a larger network system of much smarter "things," where the reliance on tagged SCFs will be replaced by autonomous computers performing a greater number of functions and with better quality (Dai & Vasarheslyi, 2016). As business is becoming more complex and dynamic, the trend of digitization will extend to the auditor's profession (Dai, 2017). The same author further argues that internal control mechanisms can be built into each individual machine or device to continuously monitor accounting data and detect abnormal transactions that exceed the expected limits.

Meeting deadlines in auditing is very important and must occur in real time. It can be difficult to reconstruct audit evidence if it is not seen in a timely manner (Hay et al., 2020). The same authors argue that users of financial reports require auditors to provide timely and pertinent information. Timely and reliable financial information is critical to day-to-day

business decisions regarding strategic planning, capital raising, credit decisions, and partnerships with suppliers or customers. However, with a computer application control audit, the auditor can provide more reliable and higher quality audit evidence (Küçükgergerli & Saridoğan, 2022).

According to Lima and Santos (2018), companies need an integrated structure that allows access to production level information in real time. For, decision making based on information that is constantly being updated, enables a faster reaction to market changes. In face of the new market demands, real-time auditing emerges as an alternative for the real-time follow-up and monitoring of processes and businesses, such as the adoption of control tools incorporated in the corporate information systems or the use of appropriate software's (Costa & Inácio, 2012). According to Chan and Vasarhelyi (2011), advances in accounting information systems as well as in ERP have enabled the generation of financial information in real time.

"Audit 4.0" can adopt service-oriented architecture to facilitate cooperation between auditors and similar service providers (Kostic & Tang, 2017). Hermann et al. (2015) described the service-oriented resource as the companies' services, SCFs, and humans made available in the IoS, which can be used by other participants. Any resource, such as production lines, assembly lines, storage, computing, labor, expertise, etc., can be made available through a network and companies can pay for the service, significantly reducing manufacturing costs, increasing profits, and cooperation among related parties, especially in those industries that have an increasing demand for specific products (Dai & Vasarhelyi, 2016). This service-oriented model reduces the initial cost of audit software and later maintenance expenses, making the technology more financially viable in the long run (Kostic & Tang, 2017).

Modular systems can adapt flexibly to changing environments or requirements by replacing or extending individual modules (Hermann et al., 2015). Looking further, Vasarhelyi et al. (2014) envisioned how modularity could enable auditors to perform auditing efficiently and flexibly, suggesting the use of audit applications - the "audit apps" - in modules, bringing them together to perform more complete analytical procedures. "Audit apps" represent a set of formalized analytical routines that can be performed by computers (Vasarhelyi et al., 2014). In this scenario, each audit app performs a single audit test based on an analysis.

Auditors can choose and deploy appropriate applications in a particular context based on the audit plan. A new set of applications would be chosen and used for different clients based on specific client risks, capabilities, business environment, and the auditors' skills working on a particular case (Vasarhelyi et al., 2014). These modular features provided by I4.0 and audit applications can be leveraged together and potentially becoming more efficient and with better quality.

From a technological perspective, newly created human knowledge continues to reshape the way we live, creating new ecosystems, developing new business models, and enhanced connection as never before seen. These innovative technologies are developed with the potential to generate giant impacts on human life and abilities, over a period, advancing human life on the planet (Antoney & Augusthy, 2019). The same authors note that banks and the other financial services industries were the first to realize the potential opportunities of technology. The initial interest was to use technology to do money

transfers, payments, clearing, and settlements. But soon the providers of these services realized that such technology can be used not only for asset transfers, but also for recording any information where the record is needed to achieve a future reference.

Digital transformation has opened new opportunities for auditing. Sensors, SCF, IoT, IoS and "Smart Factories" are the key technologies that enable the intelligence, flexibility, interconnectedness, and connectedness of I4.0 and "Audit 4.0". Other technologies such as RFID, Global Positioning System (GPS), and data analytics can support the next generation of auditing. One of the benefits of adopting the new technologies is improved product quality, improved communication, better relationships with customers, suppliers, and other stakeholders (Osnabruck & Teuteberg, 2016).

For Dai and Vasarhelyi (2016), auditors can make use of new technologies to achieve more audit-relevant information, with better execution and in real time, automate the data and its processes. Thus, their professional judgment will be reduced and at the same time the auditor will have greater assurance in their testing because the information is accurate and timely. According to Dai (2017), SCFs would play an essential role in "Audit 4.0" as they can be employed to monitor and analyse the flow of accounting data, recognizing the pattern behaviour of different business sectors, discovering irregularities or anomalies, and taking action in real time.

From machines, devices, and products that have SCFs, they can trigger the company's ERP system to record accounting transactions and business events without human intervention. Moreover, since SCFs independently store the history of business activities or the movement and condition of physical objects, such data can serve as a validation of companies' financial information Dai (2017).

Auditors can rely on IoT technology to capture a greater volume and different structures of information. In addition, IoT can facilitate the supervision of expenses and business process performance in real time (Brown-Liburd & Vasarhelyi, 2015). With the help of IoT, companies can monitor the energy consumption of machines and production lines (Shrouf et al., 2014). With the increasing automation of services, people can obtain computing resources, electronic storage, or even expertise through the internet (Dai & Vasarhelyi, 2016).

Today's audit can be presented as an online service, where audit firms can remotely, continuously, and perhaps automatically offer their services (Dai & Vasarhelyi, 2016). Companies tend to request services over the internet and audit firms will deploy their monitoring model on a cloud-based infrastructure or the company's accounting information system to analyse the data provided by the entity to be audited (Krahel & Titera, 2015). The anomalies, as well as related information, will be sent to the auditors to conduct further investigation.

Some existing auditing procedures can be automated in the context of "Smart Factories," such as automating stock valuation and measurement by tracking locations and conditions of smart products and automatically validating transactions using corresponding accounting records of related parties (Kuenkaikaew, 2013).

From the perspective of the auditor of the future, this should be someone with technological knowledge, with a conception of the ICT impacts and of the way the market develops, to be able to adapt to technological developments and thus continue to be an

integral and decisive part of a market that will be increasingly competitive (Almeida & Carvalho, 2020). The role of the audit professional is increasingly supported by Data & Analytics systems, automation, and other technologies. These new factors require new talent profiles, which is based on a multidisciplinary professional, with deep skills in information analysis, business knowledge, thus emerging the "Auditor 4.0" (Dai & Vasarhelyi, 2016).

Research or training for personal skills such as reliability and awareness can generate significant return on investment for an organization. Thus, auditors must have the ability to communicate "face to face" with other employees. This is the reason why communication skills are necessary (Al-Mohammedi, 2020).

By redirecting his or her focus, the auditor will strengthen the foundation of the practice with characteristics that may already be present, making them more relevant and that were less considered in the profession but are essential. These aspects brought together can be understood as the "5Is" of the audit of the future. The "5Is" is the acronym formed by the initials: Intelligent, Intuitive, Informed, Integrated and Insightful where Intelligent comprises the tools and technologies that take the audit experience to a higher level; Intuitive translates the access to real-time data, making the process more intuitive and even more transparent; Informed, where execution now requires knowledge about risks, regulations, markets and industries; Integrated, where delivery crosses borders, also requiring greater interaction in a global environment; Insightful, because in addition to fostering trust and transparency, it also benefits decision making (Deloitte, 2017).

According to Deloitte (2021), future auditors must be fluent in emerging technologies and be comfortable analysing and presenting complex and robust data streams, navigating the new digital world with confidence, recognizing when to leverage new technologies to better audit quality and value.

Technology is changing the way business is conducted and data is analysed, consequently the audit profession is also changing. These advances require auditors to be technologically sound to allow them to continue to meet the needs of businesses and perform their work with better quality (ACCA, 2019).

Next generation auditors need to increasingly master communication skills and critical thinking to be able to proactively solve problems and manage relationships. They must also be willing to support team members, possess strong interpersonal skills, be able to listen and explain, challenge, and build relationships across the organization. The Auditor profession will increasingly value common sense and the ability to distinguish signal from noise when it comes to information (Deloitte, 2021).

Auditors must be able to facilitate the exploration of critical audit skills such as: effective communication, relationship strategies, building and maintaining trust, navigating through power and influence, negotiation and constructive conflict skills, emotional intelligence, developing personal self-awareness, and values-based leadership (Nadziakiewicz, 2016). In this regard, Steyn (2020) grouped the soft skills of auditors into four categories: communication skills, body language, consulting skills, and facilitation skills. As verbal communication skills he considers persuasion skills, training skills, coordination skills, leadership skills and listening skills. As non-verbal communication skills it considers collaboration skills, motivational skills and influencing skills. As

consulting skills, negotiation skills, teamwork skills, interview skills, and networking skills. As facilitation skills, conflict resolution skills, marketing skills, skills based on trusting relationships and interview skills. Almeida and Carvalho (2020) concluded that the accountant will have to have certain soft skills, such as the willingness to learn and to be constantly updated, be a much more proactive person, to be able to follow and adapt to the evolution of new ICT and, consequently, the new challenges of an increasingly technological and competitive market. They will also be professionals who are increasingly specialized by areas, who will need to develop important skills, such as the ability to communicate with others, to work in teams, to get involved in processes and decision-making. Thus, the training and education of accounting professionals also needs to adapt to better prepare new professionals and allow the retraining of current accountants and auditors to adjust to new technologies and the new practices, procedures, and processes that technology will enable (Hoffman, 2017).

Auditors, who normally verify accounting documents at the end of the accounting year, can access transactions online and verification can begin at any time without waiting for the end of the year. Auditors, regulators, customers, and related parties will have the same copy of the document if they have access to public or private keys that are created by an accountant (Antoney & Augusthy, 2019). Near real-time data collection and tracking of each object can be used to create the so-called "Mirror World" of the physical world. This concept created by authors Dai and Vasarhelyi (2016) may be the beginning of something revolutionary. However, this "Mirror World" is understood as the interconnection of databases and related to networks in a common and standardized framework, facilitated and enabled using the advanced technologies provided by I4.0. The result of this framework is interconnected organizations, where transactions between different companies are collected, processed, and exchanged. In addition, auditing firms can have access to data flows, allowing them to continuously audit and monitor all transactions without a third party. This would enhance the level of assurance in audit engagements.

The "Mirror World" framework and the concept of Audit 4.0 were identified as the most suitable model to be used as the basis for the adapted version of the theoretical references enabling the use of I4.0 technologies in auditing. The benefits of this framework are that it incorporates the use of advanced features of technologies such as SCF, IoT, IoS and smart factories, real-time monitoring, interconnectedness within a single business and the ability for organizations to become more interconnected.

In the face of the volume of data and transactions that a single company performs during the period, maintaining the use of a part of the information to validate the whole, may not be efficient, given the needs of the market (Ribeiro, 2019). In this scenario, the use of new technologies, capable of certifying the authenticity and accuracy of the information and enabling data analysis on a larger scale, is essential. New I4.0 technologies enable unalterable records of all transactions, facilitating the auditors' work and offering greater confidence in audit evidence. For audit firms to capture or transform their auditors into "Auditors 4.0" they must be aligned and committed to building the skills of their human capital. In other words, the audit process, which already involved diverse teams made up of accounting, law, management, and economics professionals, must now have professionals with strong and deep knowledge in information technology, data scientists, engineering, etc., and provide training, technological tools and automation of internal processes and audit methods (Ribeiro, 2019).

The accountant's skills will need to expand to include an understanding of the key technological features and functions offered by I4.0. They should be able to advise on their adoption and their impact to the business. However, Dai and Vasarhelyi (2016) point out several challenges regarding data security and information standardization, the so-called "natural evolution that is elevating the audit profession."

## 3.2 The Role of the Auditor in Pandemic Times

The global pandemic - Covid.19 - has brought with it an impetus for change to our work landscape not seen on this scale since the first industrial revolution (Ritonga & Suyanto, 2021). Albitar et al. (2021) believe that there is a huge risk that this health crisis - Covid-19 - could degenerate into something worse than the last major global financial crisis from 2008 to 2010 and the pandemic effect would be a more difficult challenge for auditors and their clients. This represents an alarming health, economic and social crisis facing the world.

According to Albitar et al. (2021) during the pandemic, auditors experienced limitations in performing their audit procedures due to factors external to the organizations, factors within the audit organizations, and factors related to the auditors. Additionally, the authors argue that auditors and auditees had to do most of their work from home, which did not limit the number of audit samples; instead, it limited auditors from performing additional audit procedures to gather evidence that they would normally obtain from fieldwork.

For Ritonga and Suyanto (2021), because of this pandemic, expect to see a decline in audit fees, challenges in completing the continuity assessment, low levels of reliability and sufficiency of audit evidence, huge possibilities of staff loss due to illness or quarantine, and reductions in audit staff salaries, which in turn are expected to influence the quality of the audit process.

Information technology tools, big data and social media tools have a positive impact on the efficient and effective implementation of audit procedures and conducting remote audits (Al-Aamaedeh & Alhosban, 2021). Ritonga and Suyanto (2021) concluded in their study that in the pandemic, auditors could not gather audit evidence if the methods used to do so involved meeting with people face-to-face, such as during interviews and inspections. So, auditors had to use alternative audit evidence gathering and face-to-face interviews were replaced by interviews using video calls. However, this technique does not allow the auditor to see the client's body language, expressions, and spontaneous reactions. These are important indicators to see if they need additional audit procedures.

According to Al-Aamaedeh and Alhosban (2021), cloud accounting is one of the important aspects that should be followed during the impact of Covid-19 since it remotely monitors customer requirements and performs accounting and auditing operations from different locations, which helps to find discrepancies, but has also contributed to creating difficulties in the auditing process, such as being unable to perform the fieldwork in person.

### 3.3 Applications in Auditing

The term "app" refers to a software application running on computing devices such as computers, tablets, and smartphones. Apps have long been used for information retrieval purposes (Izhar & Malhotra, 2014).

The use of various devices, technologies and software that help auditors perform control and confirmation testing, analysis and verification of financial report data, and ongoing audits and supervisions are identified as Computerized Assisted Audit Techniques (CAATs) (Widuri & Gautama, 2020).

The types of CAATs are electronic spreadsheets, electronic working papers, test data, Integrated Test Facility (ITF), parallel simulation, embedded audit, Embedded Audit Modules (EAM) or control system, audit review, and Generalized Audit software (GAS).

The development of audit software applications and technology has lagged in some practical areas, but a steady evolution of automation and data analytics is providing auditors with resources to improve their efficiency and effectiveness (Anders, 2019). For this author, the auditing profession can gain from innovations in several ways, including leveraging the human mind and letting automation handle standardized tasks.

According to Pedrosa et al. (2015) auditing applications, refer to any automated tool for auditing, such as applications for generic use in auditing, computer applications to support auditing, economic auditing programs, and computer-aided auditing techniques.

Audit applications are generally defined as "formalized audit procedures" that can be performed using a computerized tool (Vasarhelyi et al., 2014). These are usually made up of a set of software packages, which automate certain audit procedures with limited need for human intervention and can be performed to conduct audit tasks that are frequently performed (Dai & Li, 2016). According to them, each application can perform a single audit task, or a combination of several related tests tailored to specific company tasks.

In this context, the use of computers and the availability of endless computer applications specific to auditing, it is important to understand what urges professionals to perform auditing techniques using technologies, as recommended by different bodies. Likewise, it is important to identify which professional demographic characteristics of auditors lead to a greater use of technologies within the profession and what are their motivations for using technologies (Pedrosa et al., 2015).

Accountants and auditors are faced with the need to perform methodical checks to the data generated by the applications they use daily (Laureano & Pedrosa, 2016). The application of I4.0 has the potential to bring fundamental changes to current audit models and make audits genuine, authentic, forward-looking, and insightful, making audits more transparent and value-adding (Asif et al., 2022; Mervelito et al., 2021).

Despite the presence in the market of different specific applications for performing these verification operations, it is known that the most common option by users is still the spreadsheet "Microsoft Excel", as an alternative to other tools that have specific options for performing certain tests. This is the case of CaseWare IDEA, which is intended for data analysis and extraction and whose use is geared towards auditors without any specific IT preparation (Laureano & Pedrosa, 2016).

This software guides the auditor so that he adequately performs the risk assessment procedures, not disregarding his professional judgment and aims to conclude the most appropriate audit response regarding the nature, extent, and timing of the tests to be performed (Ribeiro, 2017).

With this tool it is possible to build the most varied analysis sheets with current and comparative data, build reports and notes, either internal or for delivery to the client, always keeping the information of the audit work and the financial data imported to the "Working Papers", mitigating errors, and always maintaining traceability (Ribeiro, 2017).

In this context, many software vendors have been striving to create audit applications in recent years. These computer tools to support auditing can be used to facilitate the auditor's work (Laureano & Pedrosa, 2016).

As an example of these applications, we have CaseWare Working papers which is an audit program where it is possible to customize the audit programs, preparing first "Form", the "Optimizing Checklist", filling other planning forms and answering adaptation questions.

The use of this tool enables the auditor to have online access to all audit information, which means that auditors can work anywhere, even if they are not connected to an internet network. This tool is widely used in the audit context, but it requires prior preparation of the data in the original sources so that it can be correctly imported (Laureano & Pedrosa, 2016).

For a good resolution, the following functionalities are required: data import; functions of various categories and not very different from those existing in Excel; cross-referencing between tables; and data clearance. Regarding importation, it should be noted that data, whatever its origin, can be combined from various tables, but cannot be modified after being imported (Laureano & Pedrosa, 2016).

This software allows all information relating to an audit, for a given period, to be allocated in a single location, allowing the auditor to focus his attention on the relevant areas throughout the analysis of the accounts, eliminating documents associated with areas of the financial statements that are not applicable or procedures that are not applicable to the entity being audited or that are not materially relevant (Ribeiro, 2017).

In audit programs, conclusions may be developed on accounting estimates and the modification of work programs, considering the classification of the level of risk of material misstatement, for each area of the financial statements and for each of the defined assertions (Ribeiro, 2017).

Audit programs contain procedures that can be performed in relation to specific balances of the financial statements, such as net financial means, expenses, and revenues. Customized procedures can also be inserted, according to the extent of the work and the auditor's need.

# 4 Concluding Remarks

## 4.1 Conclusion

It is visible in the fieldwork that few companies are audited by generation 4.0, for a variety of reasons. Nowadays, audit work cannot only rely on the manual process, but on computer-aided audit techniques, which support and facilitate the audit work and the auditor, making it more effective and efficient. However, we corroborate with Asif et al. (2022) that in many countries and companies the application of I4.0 in auditing is in its infancy, in the 2.0 and 3.0 audit generation (see, Karapinar, 2021). Although the same authors believe that the technologies underlying I4.0 can improve the authenticity, effectiveness, and cost-effectiveness of auditing in the long term. Our fieldwork found that I4.0 will improve audit quality and open a new horizon for audit firms to adapt their working methods and processes and develop their service offerings, as found by Elommal and Manita (2022).

But if on the one hand, technological advances have had a great impact on information systems, bringing about changes in the operational and management processes of organizations, especially in the way financial information is handled, on the other hand, the new technologies provided by I4.0 have made the auditing profession more dynamic, enabling a more advanced and larger scale analysis of financial information, with the aim of identifying non-conformities in real time. Situations that were only seen with the use of samples, where the credibility of the results could be relatively low.

We found that I4.0 brought new tools to the profession and new demands on professionals. The use of audit applications is of added value, as it not only minimizes the length of the audit but also simplifies the auditor's work. Thus, auditors must be willing to learn to use computer-aided auditing tools and techniques to improve professional and organizational performance. They must develop their skills and knowledge, their soft skills, as well as new skills in communication and interaction with others, corresponding to the "Auditor 4.0" role, to meet these challenges.

Due to the increasing importance of IT knowledge, universities have a great responsibility to adapt their curriculum according to new technologies (Karapinar, 2021). Schools and Universities need to update their programs and methodologies to meet the latest technological advances and the increasingly strong and important use in audit work and the audit profession.

The auditing profession is an eternal school, and auditing professionals must be constantly learning. Because each company has its essence, its details, and its way of governing; auditors must be always ready to do the job, no matter what obstacles they may encounter along the way.

Technology will cover all the work done by the auditor, but it will not be enough. There are several factors in the human universe that cannot be mathematized. That is, there is no way to define a model for elements such as social relations, feelings, and even thought itself, which are crucial to the auditing profession, such as professional judgment and the sensitivity to verify some anomaly.

With this work it was also possible to understand that the digital transformation and the use of new technologies provided by I4.0, in addition to assisting management, are

useful in the definition of the entity's internal controls, in the improvement of decision-making processes in a timely and opportune manner, in the reduction of the length of audit procedures and, mainly, in the automation of processes, particularly in remote work/telework contexts in this new era.

The objective of this study, in fieldwork, was to analyze the impact of new I4.0 technologies on the auditing profession. Thus, it was possible to understand that the digital transformation and the use of new technologies provided by I4.0 will influence the auditing profession, in addition to serving as an aid to management and the auditing professional. These will not replace man, in his social and sentimental relations and thinking, crucial aspects for the auditing profession, but auditors should prepare themselves to understand the main changes, as Elommal and Manita (2022) refer.

## 4.2 Limitations and future lines of research

This paper contributes to the literature of both academics and practitioners by reviewing and discussing the role of technology in the field of auditing, in particular the Auditor 4.0 profession. However, being a work focused on the literature review, based on a work experienced in the field in the exercise of the Auditor profession, it presents its limitations.

In the future it should be extended to new realities and contexts, as well as in-depth study analysis of the current audit generation landscape. Exploratory and case study research using interviews with auditors and observations of companies and documents will contribute to a deeper understanding of the audit generation and the technologies underlying that generation and in particular the Audit 4.0 generation. How I4.0 technologies can improve authenticity, effectiveness and added value in the auditing profession, as well as their influence, affect and implications, negative and positive, on the profession.

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