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Accounting 4.0: a study of multiple cases in sergipan accounting organizations

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Abstract

Objective: The research seeks to understand how accounting organizations in the State of Sergipe are using the technological elements of industry 4.0.
Method: Qualitative in nature, exploratory and descriptive, the strategy of studying multiple cases in three accounting organizations was used. The sources of evidence were semi-structured interviews and document analysis. Bardin's (1977) content analysis was used.
Results: The way of using IoT, IoS, automation, M2M, big data analytics, cloud computing, systems integration, cybersecurity, QR code and virtual reality, identified technological elements of Industry 4.0, showed disagreement in their classification in relation to the literature of Industry 4.0. The principles are the same as those of Industry 4.0: interoperability; virtualization; decentralization; real-time capacity; service orientation and modularity. The results sought are: vertical, horizontal and end-to-end integration. However, the latter was not identified in any of the cases studied, even though it is the main desired result. The main challenges faced by the surveyed companies were: security and digital protection, students' technical capacity, and resistance to changes presented by their customers.
Contributions: This research contributes to the transition to a 5.0 society; advancing in academic studies; for Sergipe's Regional Accounting Council (CRC/SE), it provides strategies to improve the training of accounting professionals; for software companies, it presents organizations' quest for greater efficiency in production; for accounting organizations, it helps in the implementation of an Accounting 4.0 by presenting the challenges to be faced.

Keywords: Industry 4.0. Accounting 4.0. IOS. Systems integration. Production system in Accounting.

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Introduction

History records a new industrial revolution, which began in 2011 following the presentation of the German project known as Industry 4.0 (Rojko, 2017). Although its emergence originated in the industrial sector, its effects now also extend to the commerce and service sectors, causing repercussions throughout society with economic, social, environmental, and ethical impacts (Magalhães & Vendramini, 2018).

The economic impacts are perceived through the emergence of new business models, based on the extensive use of technologies that provide their adopters with a greater competitive advantage in the market (Magalhães & Vendramini, 2018). The social impacts are evidenced by the extinction and/or creation of new occupation profiles that occur due to the robotization of repetitive activities (Magalhães & Vendramini, 2018).

The positive environmental impacts include more efficient production, resulting in reduced use of "natural resources, waste generation, and energy consumption", as well as its utilization to aid in environmental preservation monitoring. Conversely, negative impacts arise due to the growth of electronic waste generation, driven by increased consumer consumption resulting from lowered product costs due to reduced manufacturing expenses (Magalhães & Vendramini, 2018).

The ethical impacts create the need for discussions related to accountability for errors made by autonomous machines, the use of algorithms for commercial and political purposes, and the necessity for regulation in this matter to safeguard its users (Magalhães & Vendramini, 2018).

The aforementioned impacts have been the subject of various studies, with a focus on product manufacturing (Rahman et al., 2020), but there is still a lack of research aimed at understanding how these technologies, associated with these impacts, are being utilized in the service sector (Lima & Gomes, 2020).

Lima and Gomes (2020), in a bibliometric study on the scientific production of Industry 4.0 using the Scopus database, point out that in terms of concepts, 65% of the studies are related to the Engineering field, while 15% are related to the areas of Business, Management, and Accounting. Regarding the basic technologies applied, 76% are directed towards the field of Computer Science, and none towards the field of Accounting. These data highlight the limitation of studies focused on the service sector, underscoring the need for additional research to better understand the application of Industry 4.0 technologies in this context.

Some authors (Guevara et al., 2020) assert the existence of two simultaneous revolutions, one of them being Industry 4.0, which, even before seeing its projections materialize, is already walking alongside the transition to the Fifth Revolution, also known as Society 5.0. According to Shiroishi et al. (2018), the latter is the most emergent, presented as a project by the Japanese government at CeBIT (2017), aiming to build a super-intelligent society connected by digital technologies with a focus on sustainability, producing only what is necessary to meet everyone's needs, while maintaining an active and comfortable life.

However, studying Industry 4.0 is crucial, as the path to Society 5.0 relies on making Industry 4.0 technologies available to everyone without any distinction (Guevara et al., 2020). This research contributes to the transition to a new society, advancing studies in areas that still lack development, such as the service sector (Rahman et al., 2020), specifically within the realm of Accounting (Lima & Gomes, 2020).

This research aimed to comprehend how accounting organizations in the state of Sergipe are utilizing the technological elements of Industry 4.0. To achieve this goal, the theoretical foundation of Industry 4.0 literature was employed, aiming to highlight its key technological components, perceived outcomes, and challenges encountered in its application.

The findings provide contributions to the academic community by highlighting the manner in which the technological elements of Industry 4.0 are being employed in the field of Accounting. Furthermore, it aids the CRC/SE (Regional Accounting Council of the State of Sergipe) in enhancing its professional accountant training planning, based on the evidence identified in the research. For software companies, it presents the needs of accounting organizations in Sergipe in their pursuit of greater production efficiency. For accounting organizations, it assists in the implementation of Accounting 4.0 by presenting the challenges that will need to be tackled.

2. Theoretical Framework

2.1 INDUSTRY 4.0: Terms, Concepts, and Research Status Quo

The term "Industry 4.0" was introduced at the Hannover Fair in 2011, during the presentation of the strategic plan of the German government. This plan outlined goals for the use of high technology, including the concept of the Internet of Things (IoT), to ensure its competitive leadership (Rojko, 2017).

In the literature, other synonymous terms can be found: "Smart Production," "Advanced Manufacturing," "Smart Manufacturing," or "Smart Factory." These terms are

commonly used in Europe, China, and the United States (Kagermann et al., 2013). Additionally, terms like "Internet of Things" (IoT), "Internet of Everything (IoE)," or "industrial internet" are used by the United States and Europe (Finance, 2015). This diversity of terms is connected to the classification of industrial revolution trajectories adopted in each country (Kagermann et al., 2013). In this research, the term "Industry 4.0" has been adopted.

For the German government, the concept of Industry 4.0 is a strategy that enhances competitiveness through the application of technological concepts of IoT and Cyber Physical Systems (CPS). These concepts interact both vertically and horizontally, with the perspective of generating new business models through the connection between people, objects, and systems (Kagermann et al., 2013).

The concept of Industry 4.0 is based on six fundamental principles that govern it: interoperability, virtualization, decentralization, real-time capability, service orientation, and modularity (Hermann et al., 2015).

Interoperability happens through the ability to establish communication between CPS and people in pursuit of positive outcomes, utilizing IoT and/or the Internet of Services (IoS) (Hermann et al., 2015). Virtualization refers to the process of creating a "virtual copy of the physical world" (Hermann et al., 2015, p. 12), in a way that produces data capable of interacting with various applications.

Decentralization pertains to the autonomy of decision-making within a process while preserving control over any of its stages, as observed in the use of Blockchain (Guzov et al., 2019, p. 253). Real-time capability is linked to the ability to trace a process, product, or service, providing sufficient data for instant analysis and real-time decision-making (Hermann et al., 2015).

Service orientation is connected to the concept of IoS, which is "[...] composed of participants, a service infrastructure, business models, and the services themselves" (Hermann et al., 2015, p. 9). Modularity refers to the ability to restructure machines according to the product that one wishes to produce (Hermann et al., 2015, p. 9).

Kubickova et al. (2021) found in their studies that, in engineering companies in the Czech Republic, knowledge about Industry 4.0 concepts had a "strongly moderated" relationship with the size of the company. Therefore, small companies have little to no knowledge about these concepts, with "microenterprises (about 35.4%) not even being familiar with the concept of Industry 4.0", making them vulnerable in this competitive environment.

Furthermore, according to Kubickova et al. (2021), regarding the investments being made, 42% of the participants in their research stated that they invest in technology according to market demands. For example, it was observed in Brazil that COVID-19 accelerated investments in new production methods, improved delivery logistics, and generated new forms of virtual or remote work. Additionally, there was an intensification in the use of social networks for negotiation and market presence. All these factors contributed to a more cooperative and competitive environment (Castro et al., 2020).

Regarding the technological elements used in Industry 4.0, Sacomano and Sátyro (2018) classify them into foundational elements: CPS, IoT, and IoS; structural elements: automation, machine to machine (M2M), artificial intelligence (AI), big data analytics, cloud computing, systems integration, and cybersecurity; and complementary elements: Radio Frequency Identification (RFID) tags, QR codes, virtual reality, augmented reality, and additive manufacturing or 3D printing. This classification was adopted as the foundation for this research.

To achieve success in the implementation of these elements, a planning process is necessary that considers the need for Horizontal, Vertical, and End-to-End Integration (Santos et al., 2018). However, there are several challenges to be observed in the pursuit of desired outcomes.

According to Sakurai and Zuchi (2018), in Brazil, the government needs to allocate more investments in digital infrastructure, create lines of credit, and establish public policies that enhance the technical capabilities of students and workers, training them to work with Industry 4.0 concepts. Concerning companies, they require strategic planning to overcome challenges related to cybersecurity, digital protection, standardization, work organization, cognitive capacity, and the inclusion of small and micro-enterprises (SMEs) in the process of horizontal integration.

All of this information is readily available in the literature; studies on Industry 4.0, according to Muhuri et al. (2019), are now more consolidated. The initial publications related to the topic were indexed in the Scopus database and Web of Science (WoS) in 2012, with 3 articles, and in 2013, with 2 articles, respectively.

Regarding the status quo, Lima and Gomes (2020) conducted a bibliometric study on the scientific production of Industry 4.0 using the Scopus database. The authors found that, concerning the concepts of Industry 4.0, 65% of the studies are related to the field of Engineering, while 15% were related to Business, Management, and Accounting. When observing basic technologies, 76% are directed towards Computer Science, and none towards the field of Accounting.

According to Mariani and Borghi (2019), the application of Industry 4.0 in the service sector has been overlooked

by researchers. It is necessary to move beyond this embryonic stage in the service sector to showcase the possibilities of adopting Industry 4.0 technologies in this segment (Mariani and Borghi, 2019). "Adopting the paradigm and vision of Industry 4.0 enhances productive and financial capacity, increasing competitiveness through the improvement of service quality and business processes" (Mariani & Borghi, 2019, p. 19).

2.2 ACCOUNTING 4.0: Terms and concepts

Some authors use the term "digital accounting" (Tadeu et al., 2021) to refer to the way of conducting accounting using technological elements from the Fourth Industrial Revolution. In this research, the term "Accounting 4.0" was adopted, which, according to the concept by Franco et al. (2020), is related to Industry 4.0 and influences how accounting services are produced, utilizing technological tools integrated by systems that communicate, optimizing processes and generating intelligent products.

In Accounting 4.0, it becomes possible to achieve transparency in information and maintain permanent records (Guzov et al., 2019). The primary tools of this production system include big data (Richins et al., 2017), blockchain (Guzov et al., 2019), and IoT (Yilmaz & Hazar, 2019).

The adoption of concepts and technological tools from Industry 4.0 in accounting organizations can lead to significant gains in productivity (Hoffman, 2018). Therefore, understanding how these technologies are being used is now a necessity, as it can be the difference between those who will evolve alongside this technological revolution and those who might become obsolete if they fail to adapt to the current market needs (Hoffman, 2018).

3. Methodoigical Procedures

3.1 RESEARCH QUESTIONS

According to Triviños (1987), the research question aims to guide the researcher towards the goal they intend to achieve, assisting in the development of strategies to address these questions. To fulfill this objective, it is essential that the question is at the very least precise, clear, and objective. In this study, the defined research questions are listed below, serving as a foundation for guiding the entire research process, including assisting in the formulation of interview questions:

1. What technological elements from Industry 4.0 are used in accounting organizations in the state of Sergipe?
2. How are these technological elements being utilized?
3. Why are these technological elements being used?
4. What are the challenges for accounting organizations implementing Accounting 4.0?

3.2 CASE STUDY PROTOCOL

The case study protocol includes the instrument and procedures for its utilization in the research. It serves to guide the researcher in crafting the case study, contributing to enhancing the research's reliability (Yin, 2001).

For the conduction of this research, the following case study protocol was utilized:

1. Select the accounting organizations for the study.
2. Create the script for documentary research.
3. Conduct documentary research in the selected accounting organizations and on their websites, as well as at the Brazilian Federal Revenue Service (RFB), the Simples Nacional Portal, and DataSEBRAE, with the aim of identifying the profile of the participating organizations in the case study.
4. Develop a semi-structured interview script aligned with the study's analytical categories.
5. Schedule interviews with the managers and staff of the selected accounting organizations.
6. Conduct the interviews.
7. Analyze the evidence.
8. Compose the final report of the case study.

3.3 EVIDENCE SOURCES

For the current research, the following sources of evidence were used:

1. Document Analysis: Conducted from May 25, 2022 to August 5, 2022.

2. Data Extraction: Websites of the accounting organizations, selected through Google Forms. The link was provided to the managers of the participating accounting organizations; on the Brazilian Federal Revenue Service (RFB) website; the Simples Nacional Portal; and DataSEBRAE.

3. Interviews: Conducted between June 13, 2022 and August 9, 2022, totaling a duration of 12 hours and 20 minutes. One manager or designated employee from the organization, along with 10% or more of the employees from the tax, accounting, personnel, and paralegal/ infralegal departments of the selected cases, were interviewed.

3.4 CRITERIA FOR CASE SELECTION

The criteria for case selection were cumulatively as follows:

- Being an accounting organization;
- Being an active member of CRC-SE (Regional Accounting Council of Sergipe). This criterion yielded 673 results;
- Having a fiscal domicile in the state of Sergipe. Out of the 673, 117 were domiciled in another state and

were operating through communication, leaving only 556 active organizations domiciled in Sergipe;
- Having some online presence that allows for location identification and providing a client-specific restricted area on their website. Only 33 organizations met this criterion;
- The manager should acknowledge that their accounting organization utilizes Accounting 4.0. Only 3 organizations agreed to participate in the research and met this criterion.

In the pilot case, in addition to the criteria mentioned above, factors like accessibility to the location and access to employees and managers in or out of working hours were considered. Therefore, the pilot case was an organization in which the researcher had non-familial connections with those involved in the research, making it easier to conduct the study according to her time availability.

3.5 DATA ANALYSIS

For data analysis in this research, the content analysis method by Bardin (1977) was employed.

After Material Preparation, carried out during the data organization phase, the second step, Material Exploration, began. This involved encoding the units of records through thematic analysis. Subsequently, the data was segregated into the predefined categories, as per **Table 1**, with no requirement for the creation of new categories. Finally, the last stage of content analysis was Results Processing, inference, and interpretation, which guided the outcomes of this research.

Table 1: Categories and Analysis Elements

Research Questions	Category	Analysis Elements / Units of Records
What technological elements from Industry 4.0 are used in accounting organizations in the state of Sergipe?	Technological elements	**Basic** or Fundamental Elements of Industry 4.0: CPS, IoT, and IoS; **Structuring Elements** of Industry 4.0: Automation, M2M, AI, Big Data Analytics, Cloud Computing, System Integration, and Cybersecurity; **Complementary Elements** of Industry 4.0: RFID Tags, QR Codes, Virtual Reality, Augmented Reality, and Additive Manufacturing or 3D Printing.
How are these technological elements being utilized?	Fundamental principles	Interoperability; Virtualization; Decentralization; Real-time Capability; Service Orientation; Modularity.
Why are these technological elements being used?	Expected results	Horizontal Integration; Vertical Integration; End-to-End Integration.
What are the challenges for accounting organizations implementing Accounting 4.0?	Challenges	**Governmental Competence**: available digital infrastructure, access to credit lines, and technical capacity of students and workers for the 4.0 job market. **Private Organizations' Competence:** digital security and protection, standardization, work organization, cognitive capacity, integration with SMEs, and resistance to change.

4. Research Results

To ensure the confidentiality of participants, their real names were replaced. Therefore, to refer to the organizations, the letter "C" was used along with the numeral representing the order in which they participated in the research. For example, the first participating organization was referred to as "C1," where "C" stands for accounting organization and "1" represents the first to participate. For managers and employees, the letter "P" was used along with the numeral representing the order of their participation in that organization.

Three accounting organizations participated in this research: C1, C2, and C3. C1 was the pilot case, involving one director and seven employees. In C2, a representative designated by the manager and two other employees participated. In C3, one director and two employees participated. The participating employees belonged to the departments: accounting, tax, personnel, and paralegal/infralegal. In total, fourteen participants were interviewed.

Table 2 - Characteristics of the Studied Accounting Organizations

Analyzed Characteristics in the Accounting Organization	C1	C2	C3
Size	EPP (Small-sized company)	EPP (Small-sized company)	ME (Microenterprise)
No. of employees in Accounting	21	1	2
No. of employees in Tax	24	2	2
No. of employees in Personnel	17	1	2
No. of employees in Paralegal/Infralegal	4	1	1
Years of operation	31	6	12
Client segment	Service; Commerce and Industry	Service and Commerce	Service; Commerce and Industry
Organization's taxation	Simples Nacional (National Simple)	Lucro Presumido (Presumed Profit)	Simples Nacional (National Simple)
Total clients in Sergipe	428	49	63
Accounting system used	Alterdata	Alterdata	Domínio Sistemas
Electronic Document Management System (GED)	Estado Virtual (EVDOC)	Acessórias and HubCount	ONVIO
Marketshare = Total Clients ÷ (Total Companies in Sergipe - Total Accounting Companies)	428 ÷ (126,675 - 577) = 0.34%	49 ÷ (126,675 -577) = 0.04%	63 ÷ (126,675 - 577) = 0.05%

4.1 COMPARATIVE ANALYSIS

4.1.1 Technological elements

In the study by Kubickova et al. (2021), a "strongly moderated" relationship between company size and knowledge about Industry 4.0 concepts was observed. In the accounting organizations of this case study, two were Small-Sized Companies (EPP), and one was a Microenterprise (ME). When participants were asked if they were familiar with the term "Industry 4.0", only 25% in C1 and 33.3% in both C2 and C3 replied that they had "heard of it". Therefore, the studied SMEs (small and medium enterprises) demonstrated limited knowledge

about Industry 4.0 concepts, which form the foundation of Accounting 4.0.

Regarding the elements used in accounting, when comparing the classification given by Sacomano and Sátyro (2018), it was found in this study that **IoT** is used to complement other technologies, while CPS was not mentioned. On the other hand, **IoS** is fundamental in Accounting 4.0 because, as stated by Hermann et al. (2015, p. 9), "It allows service providers to offer their services over the Internet", precisely what has been done by the studied organizations.

During the document analysis, it was found that companies C1, C2, and C3 utilize **automation** in their chatbot for WhatsApp customer support. According to Ribeiro (2003, p.1), automation "should add some kind of intelligence to the machine so that it performs its task more efficiently," which is exactly how it's being used. In C1, automation is also used in the timekeeping system with direct input into the human resources department module. In C2, a robot is used to send obligations to clients and monitor their viewing.

According to Verma et al. (2016), the **M2M** element utilizes full automation, meaning without direct human intervention. This approach is adopted by companies C1, C2, and C3 in controlling Certificates of Tax Clearance (CND). On predefined dates, the systems verify with relevant authorities and issue the CND. If there are any issues, the manager is notified. In C1, automation is also seen in the process of turning on the organization's computers at the start and turning them off at the end of each working day. In C3, it's used for capturing and recording invoices from their clients.

Big data analytics was mentioned as being used only by company C1. The other companies state that they maintain a database with their clients' information, but they do not use the information to determine user profiles.

Cloud computing is used by C1, C2, and C3 for storing files received and sent by clients. According to the concept by Santos et al. (2018, p. 111), this procedure "provides storage solutions and enables information exchange and management." None of the organizations participating in the study has their accounting system in the cloud.

Integration of systems directly contributes to achieving maximum efficiency in accounting. According to Sacomano and Sátyro (2018), it's the process of merging systems for the full functioning of Industry 4.0. The studied organizations perform integrations between accounting modules and their clients' financial systems. C2 went further, and during document analysis, a partnership was identified between C2 and Cora Digital Bank, enabling direct integration of clients' bank statements into C2's accounting system, an excellent example of horizontal integration.

Regarding **cybersecurity**, although classified as a structural element by Sacomano and Sátyro (2018), it deserves a lot of attention and investment. According to Verizon Communications (2022), there was a 13% increase in ransomware attacks in 2021, with "82% of breaches involving a human element, including attacks, errors, and misuse."

According to the interviewees, organizations have been seeking ways, within their financial capabilities, to prevent cyberattacks. Among the solutions mentioned by C2 and C3, the use of cloud computing stands out as a means to achieve cybersecurity. The concept for this technological element is "[...] the protection of systems connected to the Internet, including hardware, software, and data, from cyberattacks" (Galoyan, 2019, p. 3). It is observed, however, that both C2 and C3 are not primarily focused on preventing an attack, but rather on outsourcing the responsibility in case of a security incident.

C1 demonstrated an understanding of the importance of cybersecurity and invests in dedicated IT, licensed software, and regularly updated antivirus systems. Both C1 and C2 view compliance with the General Data Protection Regulation (GDPR) as a positive factor in enhancing cybersecurity, with training provided to employees to maximize the security of data processed within the organization. In the case of C3, it was reported that the organization is already compliant with GDPR; however, the document analysis did not locate a specific area or contact information for the data controller within that organization.

The **QR code** was mentioned only by C1, but in a complementary context, such as in receiving payments for services rendered, without a direct connection to the final accounting product.

Finally, **Virtual Reality**, mentioned by C1, C2, and C3, is used for conducting remote meetings through the Google Meet platform. According to Kirner and Kirner (2011), virtual reality immerses users in a virtual environment, as mentioned by the participants.

4.1.2 Fundamental principles

According to Hermann et al. (2015), the fundamental principles of Industry 4.0 help in identifying potential pilots that can be implemented in Industry 4.0. These pilots were identified and applied in Accounting 4.0.

Interoperability in Accounting 4.0 is associated with system integration, M2M communication, and automation. It requires these elements to import and export files from financial systems, banks, files required by tax and accounting standards, and even within the integration

of accounting modules. To implement interoperability, there needs to be a seamless communication mechanism capable of connecting these technologies.

According to Santos et al. (2018), interoperability is responsible for communication in physical, virtual, or hybrid environments, enabling those involved to interoperate in the exchange of information. Therefore, this information needs to be understandable for all users who have access to it. Thus, interoperability is essential in the utilization of Industry 4.0 technological elements in Accounting 4.0.

Regarding **virtualization**, the companies C1, C2, and C3 have applied it in the use of IoS and System Integration - processes have been digitized to enable the use of these technologies. Digitization, or virtualization, was especially reported by companies C1 and C2, which adopt a paperless policy. Hermann et al. (2015) define virtualization as the ability to transport something physical into the virtual realm. Participants from companies C1, C2, and C3 reported the practice of digitizing physical documents, which are stored in the organization's cloud computing system.

Regarding **decentralization**, there was a need for improvement to achieve a maturity level that could lead organizations to full Accounting 4.0 implementation. In companies C1, C2, and C3, the need to decentralize information that is currently concentrated with the client was identified, which is delaying the accounting process and not achieving the required timeliness to assist managers in decision-making.

Following the essence of this principle's concept, as presented by Hermann et al. (2015), the participants in the process should have the necessary tools to carry out their tasks independently. Only in cases of failures or unexpected occurrences, the consultation of a higher instance is necessary. Therefore, all steps should be recorded in the system to enable responsible parties to make decisions when necessary in such situations.

The organizations C1, C2, and C3 use technological elements in a decentralized manner. However, there was a perceived need to expand this decentralization to all stages of the process and not just in isolated parts, as is currently the case. This is because some stages still remain centralized with the client. This situation ends up slowing down the process as the data to be recorded is not shared within the agreed-upon contract deadlines.

> [...] because it takes too long, so I believe that for the office to truly be in a 4.0 accounting, there should already be integration between the client and the office itself [...] I would complete my tasks, like, 10 times faster if this process was skipped, you know? (P7).

The **real-time capability** of companies C1, C2, and C3 was mentioned in the process of tracking the viewing of documents sent to clients and accessing their financial information through integration with their financial systems. According to Hermann et al. (2015), real-time capability refers to the ability to collect and analyze data as events occur, providing fast and secure information about production status. However, currently, this speed does not exist due to the dependency on the client to send their documentation.

The **Service Orientation**, according to Hermann et al. (2015), refers to services offered within or outside the company through the IoS. This orientation was reported by participants from C1, C2, and C3, who apply it through automated WhatsApp customer service, services available on their websites, as well as other services offered through IoS. These include a client application, M2M for issuing certificates, cloud computing provided to clients for cloud-based document access or storage, and system integration through financial system platforms.

Lastly, **modularity** refers to the ability to restructure according to production, as stated by Hermann et al. (2015). In the Accounting 4.0 of companies C1, C2, and C3, modularity is evident in the acquisition of individual accounting system modules based on the organization's needs, the integration capability with distinct financial modules as per each client's requirements, and the interoperability-enabled capacity to work with different file types for service execution.

4.1.3 Expected results

According to Santos et al. (2018), vertical, horizontal, and end-to-end integrations are necessary to add value to production. In vertical integration, all departments within the factory are interconnected, leading to a systematic view of the factory. Horizontal integration links suppliers, customers, and the factory, allowing instant communication for making immediate decisions based on accurate information about the current situation. Once vertical and horizontal integration are achieved, end-to-end integration is accomplished, connecting the entire value chain in real-time.

According to Frank et al. (2019), to achieve **vertical integration**, the first step is to digitize processes, integrating them into the network across all departments, allowing everyone to access any stage, which should be monitored in real-time by the system.

Among the studied companies, C2 and C3 reported that internal communication does not occur within the system due to being small organizations. Therefore, the upper levels cannot access the actions being carried out in operations. This is different from C1, which records all internal requests through the CRM Pack tool from

Alterdata, enabling monitoring by managers.

> [...] the departments, they have this technological integration through CRM, right? [...] The Alterdata system itself, right? And... the system, well, I think all the digital systems we use today are part of this... this range of technology that allows this 4.0 management (P1).

In C1, C2, and C3, there is integration between the modules that are used, such as fiscal, personnel, and accounting. This allows the departments to access the necessary information to proceed with the production of their services. Another factor is the digitization of documents and storage in cloud computing, done by all the studied organizations, which demonstrates the pursuit of verticalization.

C1, C2, and C3, even though unaware of the term **"horizontal integration"**, exhibited this type of integration through the use of accounting system integration with the financial systems of clients. According to the reports, this was made possible by providing a client area on the website of each organization. In the case of C2, they even managed to integrate directly with the Cora bank, obtaining the banking transactions of their common clients.

According to Kagermann et al. (2013), horizontal integration occurs with the aim of integrating various systems involved in the business. In this way, multiple companies collaborate to create an end-to-end connection between the company, customers, and suppliers.

The studied organizations have achieved partial horizontal integration, as they still rely on some clients who reject the tools to share the necessary information for the production of the contracted services.

Achieving horizontal integration will enable organizations to receive real-time information, allowing them to provide their clients with accounting reports containing up-to-date financial information about their companies. For instance, when a client makes a payment, this information should be integrated into the accounting system, enabling analysts to perform necessary reconciliations and generate useful insights for managerial decision-making.

End-to-end integration was not identified in any of the studied organizations, as it will only be achieved when it becomes possible to connect the internal elements of the company through vertical integration with customers and suppliers, also ensuring horizontal integration. In this way, both types of integration could be achieved, meaning that all business elements, both within and outside the company, establish a connection capable of providing real-time information among all business participants. This concept is in line with the perspective of Kagermann et al. (2013).

4.1.4 Challenges

According to Santos et al. (2018), despite efforts from governments, organizations, and academics, there are still many challenges to overcome for Industry 4.0 to become a complete reality. In the analyses conducted in C1, C2, and C3, Accounting 4.0 is not yet a reality, as there are challenges to be overcome, especially for accounting organizations that operate outside of companies and depend on information centralized within clients.

The interviewees from C1, C2, and C3 stated that they are not aware of any **credit lines** that have assisted the accounting organization in implementing Accounting 4.0. However, literature suggests that the government needs to facilitate access to credit lines that allow the market to invest in Industry 4.0 technologies (Sakurai & Zuchi, 2018).

All participants confirmed that they are not aware of available credit lines. However, only C3 mentioned complaints about their relationship with banks. According to P12, the banking relationship process is so bureaucratic that, in some cases, they give up even on simple tasks like opening an account, let alone trying to obtain credit to assist the business.

The **technical skills of students and workers for the Industry 4.0 job market** were mentioned by both C1 and C3 as a "challenge". According to these participants, educational institutions do not adequately prepare students for an Accounting 4.0 (Industry 4.0) environment. They emphasized that educational institutions need to be better equipped and should provide students with the necessary skills for the evolving professional landscape of Industry 4.0 (Sakurai & Zuchi, 2018).

For C3, it has been challenging to find professionals with the ability to understand the organization's needs and actively seek out the technologies of Accounting 4.0 available in the market.

Security and digital protection were mentioned as a challenge only by C1. The others, although they acknowledge the importance, believe they are already doing what they can and do not see it as an essential element. Therefore, they do not consider it to be a challenge that requires more attention than they are already giving to this aspect.

Santos et al. (2018) emphasize the importance of giving due attention to cybersecurity, as the increased use of new intelligent technologies also increases the risks associated with the use of data transmitted over networks. C1 demonstrated a strong awareness of these risks. The interviewees reported that the company has been making

investments to ensure a consistently protected technology environment, staying vigilant about updates to prevent cybersecurity incidents.

According to Santos et al. (2018), digital security and protection encompass factors such as the safeguarding of personal data and privacy. In Brazil, the LGPD (General Data Protection Law), enacted in 2018, aims to protect the data of natural persons. Regarding compliance with this law as a form of digital security protection, all the organizations participating in the research affirmed their compliance. However, C3 did not provide clear evidence of this compliance. During the document analysis, no specific area related to LGPD was found on their website for users to interact in case of doubts or requests related to the law.

Regarding **standardization**, C1 identified it as a challenge due to the difficulty of finding tools capable of interacting autonomously with other systems to integrate client transactions directly with the accounting system. The participants are unsure if this is feasible, but they recognize it as necessary and thus a challenge.

> [...] there should already be integration between the client and the office itself [...] they would put it on the server, and the robot server would already read the statement, import it into the office's accounting system [...] I would only need to verify if everything is really okay! Correct! According to the document that the company sent [...] I would do my tasks, like in... 10 times faster [...] (P7).

According to Santos et al. (2018), standardization is one of the greatest challenges to overcome, as it must ensure interoperability among systems in a way that provides effective communication between all processes and their users. In C3, it was reported that the lack of direct integration with client transactions makes their process inefficient, as it's not possible to decentralize this information, remaining dependent on clients sending the information:

> [...] in my case, accounting, I heavily rely on the client. So, I don't have a tool that gives me autonomy to use their system. Usually, I always request through WhatsApp or through ONVIO for them to send it to me, and only then can I carry out my activities (P14).

Regarding **work organization**, as mentioned by Santos et al. (2018), it refers to the company's ability to use machines for repetitive tasks that don't require creativity, while humans should have their intellectual potentials better utilized for the company. Only C1 mentioned this challenge, and according to some of the interviewees, the way technology is implemented can lead to rejection by employees.

> The issue of dialogue with employees, well, I think that would be the way to shorten this path, to make it easier, right? Both for one side and the other, in terms of... and management has to take this... this initiative, take the first step to approach the employee and have a conversation. Without dialogue, it... will be more difficult to carry this forward [...] (P2).

When asked about whether **SMEs** pose a challenge in implementing Accounting 4.0, only the employees of C3 considered them detrimental to achieving horizontal integration, as they tend to refuse more often to invest in technologies that automate their processes.

According to Santos et al. (2018), digitizing SMEs has been a challenge because they still do not understand the competitive advantages of using Industry 4.0 technologies. The authors suggest that raising awareness about overcoming investment difficulties and acquiring available IT professionals can be achieved through a multifaceted strategy.

Finally, the greatest challenge faced for achieving Accounting 4.0 in the companies C1, C2, and C3 is resistance to change, exhibited by both their employees and clients. Despite demonstrating the benefits of adopting technologies, some employees feel insecure about relying on machines, and some clients decline the offered technologies.

> Both academic and managerial literature tend to point out resistance to change – that is, any behavior aimed at maintaining the status quo in the face of pressure to alter it – as one of the main barriers to successful change [...] and despite all the "recipes," in fact, we don't know much about what resistance to change is, its causes, when it's more likely to occur, the effect it can (or cannot) have on transformation efforts, or the methods that exist to deal with it [...] (Hernandez & Caldas, 2001, p. 32).

According to P1, this resistance is associated with the culture of employees and clients who don't feel comfortable with changes, as they would need to move away from their status quo, demanding a shift in behavior or knowledge.

> Firstly, it's a cultural issue, you know? It applies to both internal individuals, like employees, and also to clients. These technologies often don't sit well with people simply because, even though they make things easier, they take them out of their comfort zone. Any change, even if it's for the better, can be uncomfortable. (P1).

So, in order to achieve horizontal integration, it's necessary

to overcome the challenge of resistance to change, eliminating the intermediation carried out by clients in the information submission process. This would make the entire process automated, efficient, and truly capable of being a source of information for managerial decision-making.

> [...] much of it is a result of the resistance from some clients to use the tool [...] there is a significant resistance from them to use what is offered [...] not because they don't know how, no! It's because they don't want to, they prefer to call, they prefer to contact us in a different way [...] (P9).
> [...] we have an app here, and people resist using it, even though the application is much better than just sending an email, but the person still thinks that no, that it's not good, that they need to have email, that they need to have that, that the app will complicate things, so there's all of that, right? (P12).

The above accounts sum up the perspectives of all participants who don't understand the reasons behind this resistance to change, even though adopting these changes could improve their services. The clients exhibit indifference, which negatively affects the final outcomes.

5. Final Considerations

The overall aim of this research was to comprehend how accounting organizations in the state of Sergipe are utilizing the technological elements of Industry 4.0. The findings revealed that artificial intelligence, 3D printing, RFID tags, augmented reality, and CPS are not being employed in the studied accounting organizations. There are considerable uncertainties about how to apply CPS in accounting, necessitating further investigation into its application within these organizations.

The elements that were mentioned or had their usage identified were: IoT, IoS, automation, M2M, big data analytics, cloud computing, integration of systems, cybersecurity, QR code, and virtual reality.

In the literature, big data, according to Richins et al. (2017), blockchain, as stated by Guzov et al. (2019), and IoT, according to Yilmaz and Hazar (2019), are presented as the main tools of Industry 4.0 used in Accounting 4.0. However, only company C1 mentioned big data. Regarding IoT, it is used only in a complementary manner. As for blockchain, none of the participants mentioned it.

All the fundamental principles of Industry 4.0 are also applied in the studied organizations. Decentralization is still in its early stages, so some processes depend on feedback from clients, which hinders real-time capability.

The classification considered by Sacomano and Sátyro (2018), used as a reference in this research, presents a discrepancy between Industry 4.0 and Accounting 4.0. For instance, IoT, which Sacomano and Sátyro (2018) classify as a fundamental element, is used in the studied organizations in a complementary manner for equipment control, not directly involved in the accounting process. On the other hand, the integration of systems, classified as a structural element, was perceived as essential to talk about Accounting 4.0.

All organizations are striving for end-to-end integration, even though they might not be familiar with the technical term. However, they need to achieve full horizontal integration before they can attain end-to-end integration.

Horizontal integration is partial due to resistance to change, particularly from clients. Despite companies presenting and offering tools to facilitate this integration, clients are resistant to adopting them, preferring to stick with traditional methods. This centralizes access to information with the clients, preventing organizations from progressing in implementing the principles of decentralization and real-time capability, which are essential for eventually achieving end-to-end integration.

Other challenges were mentioned, even if only by C1, apart from resistance to change, which is the biggest challenge. One of these challenges is digital security and protection. While it's a fundamental factor for Accounting 4.0, as its input consists of data shared on computer networks and is vulnerable to potential cyberattacks, this study indicates that it's an area that needs attention in working with accounting organizations in order to enhance the security of information exchanged in horizontal integration.

Another challenge, this time mentioned by all organizations, was the technical skills of students. There's a need for restructuring the curriculum of Accounting courses, adapting it to Accounting 4.0, and introducing fundamental technologies of this new digital era to the students.

Given the presented results, the research contributes to ongoing discussions related to the topic of Accounting 4.0. It is the first study to analyze the Industry 4.0 technological elements being used in accounting organizations in Sergipe. This research benefits both the academic community by shedding light on this area and providing insights into the utilization of Industry 4.0 technologies in accounting organizations, and also professionals in the accounting field by highlighting the need for skilled professionals in the 4.0 market with expertise in these new intelligent technologies.

For accounting organizations, this research provides valuable insights into the technologies that are currently

being used. The classification of these technologies in the research allows for the establishment of priorities in their implementation. It suggests that organizations should aim to achieve the basic level first, then the structural level, and finally the complementary level. For technology companies, this research highlights the market demand for integration tools that ensure end-to-end integration in the accounting sector. This understanding can guide technology providers in developing solutions that address the specific needs of the accounting industry in terms of integration and technological advancement.

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