Digital affordances and remote public audit practice

Abstract

As public sector organisations are undergoing a digital transformation, public auditing is increasingly relying on technology to enable it to collect and analyse large amounts of data. We analyse how the introduction and development of digital artifacts in a governmental audit setting end up affording audit practices. Focusing on the introduction of computer-assisted audit tools (CAATTs) developed by Courts of Accounts in Brazil our findings indicate that the digital infrastructure maintained by each Court in Brazil is the material centre of a dominant frame of remote compliance audit practice. Besides CAATTs' interface, scripts and algorithms in the infrastructure's backstage also add to the affordance of the digital devices used by auditors – i.e., auditors' action possibilities moulded by technology. Through interviews with governmental auditors we provide evidence on how computer-assisted audit tools afford their practices while showing that auditors are not fully aware of how their scepticism and autonomy are being affected by the introduction of such devices and by the reinforcement of remote audit practice.

Keywords: Digital infrastructure, data-driven audit, remote audit, professional scepticism

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1. Introduction

> *SAIs could aim to make better use of data analytics in audits [... by] introducing new techniques into the practice of public audit [...] It will shorten fieldwork time and allow for regular monitoring of follow-up.*
>
> – INTOSAI's Moscow Declaration, 2019

This excerpt from the Moscow Declaration indicates what supreme audit institutions (SAIs) collectively expect the future of governmental audit practice to be. Auditors are required to combine evidence derived from computer-assisted audit tools and techniques (CAATT) usage with other types of evidence and *maintain an open and objective mind* – rather than relying exclusively on data analysis (Requirement 77; ISSAI-4000, INTOSAI, 2000). This exemplifies how public sector audit practices are being collectively defined, including by the usage of normative recommendations, while being influenced by the adoption of technologies.

Considerable empirical research on the private sector has explored the interactions between computer-based artifacts and the auditing and accounting professions (Salijeni, Samsonova-Taddei, & Turley, 2021). Studies address agency augmentation and automation (Murray, Rhymer, & Sirmon, 2021; Salijeni et al., 2021) and the benefits of remote auditing (Teeter, Alles, & Vasarhelyi, 2010); still, there are concerns about how digitalisation might reduce professional autonomy (Brown-Liburd, Issa, & Lombardi, 2015) among other ethical issues (Martin, 2019).

Although insights from the private sector may apply to public sector auditing (Hay & Corderi, 2018), extant literature overlooks the effects of digital devices on governmental audit practices (D'Agostino et al., 2021; Mattei, Grossi & Guthrie, 2021). However, due to varying audit objectives and characteristics, when comparing public and private audit settings, we maintain that the effects of implementing digital devices may change. While private audit organisations focus on financial auditing, public audit organisations' objectives are broader including performance and compliance auditing (Dahanayake, 2021). Our study aims to address this lack of understanding of the effects that stem from technology adoption in public sector auditing by specifically looking at compliance auditing; i.e., auditing the auditees' adherence to relevant laws and regulations and the conduct of officials regarding *'sound financial management and operational management'* (INTOSAI, 2020).

Despite INTOSAI's normative recommendations on digitalisation, we argue that the development, implementation, and use of technology to support public sector audit practices are collectively negotiated and implemented in professional practice via collective-action frames (Gray, Purdy, & Ansari, 2015; Purdy, Ansari & Gray, 2017). Moreover, the introduction of digital devices may lead to a set of interconnected information systems whose boundaries are constantly renegotiated by users – so-called 'digital infrastructures' (Fürstenau, Baiyere, & Kliewer, 2019). Such infrastructures and the embarked devices end up affording professional practice – i.e., as they change how governmental auditors make sense of and use technology over time (Essén & Värlander,

2018).

Normative recommendations are not the only factor that should be considered when governmental audit organisations move towards digitalisation. The introduction of digital devices in a governmental auditing setting might continuously change how auditors perceive, use, and integrate the emerging technology into their routines. Affordances literature could be a useful tool to explore how human and computer agency interact, and how professional practice at governmental audit organisations may be moulded by such interactions. The affordance of a technology opens up *'possibilities for goal-oriented action'* to individuals interacting with it (Markus & Silver, 2008, p.622). Therefore, auditors using a particular technology to execute a goal-oriented task may have their practice shaped by scripts and data visualisation dashboards, for instance, as discussed by Salijeni et al.(2021) in the private auditing setting.

We analyse how the introduction and development of digital artifacts in a governmental audit setting end up affording audit practices. We depart from previous studies that describe how remote compliance audit has been consolidated over many years as the dominant frame of (compliance) audit practice by Brazilian public sector audit organisations (Courts of Accounts), and how the proliferation of digital infrastructures has contributed to the emergence of such a frame (Aquino, Lino & Azevedo, 2021). The digital infrastructure maintained by each Court remotely connects the information systems of government organisations (auditees) and separate units of software (i.e., modules) from computer-assisted audit tools and techniques (CAATT) that are used by auditors to perform their analysis remotely.

Our findings reveal that the current features of typical CAATT and the backstage of the digital audit infrastructure currently in place in Brazilian Courts of Accounts have emerged from the data collection systems developed by the information and communication technology teams; these were collectively accepted by auditors, thereby affording remote audit practices. Such a dominant remote frame of audit compliance drives auditors' goals, i.e., what they intend or are expected to deliver when using technology. Therefore, governmental auditors' perceptions and use of the introduced digital artifacts reinforce the values and rules of the current remote auditing practices, resulting in less autonomy and reflectiveness about the audit task.

2. The introduction of digital artifacts into audit practice

Introducing digital artifacts in a professional setting seems to drive professionals differently. Some perceived positive effects are the automation of repetitive work (Davenport, 2018) and augmented agency (Salijeni et al., 2021); while reductions in work flexibility and privacy (Kellogg, Valentine & Christin, 2020; Lindebaum, Vesa, & den Hond, 2020), or increased usage of rankings based on opaque algorithms (Martin, 2019) are undesirable effects.

Extant literature explores how the interaction between computer-based artifacts and human agency (i.e., material-human interaction) affects organisational and professional practice (Murray et al., 2021) through the affordance of digital artifacts, – which includes the social influence of rankings (Pollock & D'Adderio, 2012), big-data applications, scripts, and data visualisation (Salijeni et al., 2021).

Affordances are *'the possibilities for goal-oriented action afforded to specific user groups by technical objects'* (Markus & Silver, 2008, p.622). Accordingly, digital devices have

materiality, i.e., particular enduring forms in place and time (Leonardi,2013). Moreover, they have the performativity to afford a particular set of actions when individuals interact with them (material agency). However, individuals also have intentionality and are goal-oriented when interacting with such devices (human/social agency).

Such material-human interactions happen in a social setting; e.g., auditors have professional roles and status that are connected to a hierarchy within broader networks and power relationships. Since auditors and general technology users are goal-oriented, they will use the device for one purpose, e.g., writing a text or taking notes when using a word-processing device. Thus, technology or digital device affords some action by the user. However, as people come to technology with diverse goals, a technology's affordance can change across contexts even though its materiality does not (Leonardi, 2011).

Therefore, affordances from technologies are relational, changeable, created when users interact with the intrinsic properties of the technology (Pentzold & Bischof, 2019). Thus, affordances are dependent on collective meanings and shared practices communicated about that technology (McVeigh-Schultz & Baym,2015). Several digital artifacts are often available in the same professional work setting; they simultaneously and jointly afford users at work, but how they do this are distinct, as each user develops an understanding about their usability (McVeigh-Schultz & Baym,2015), which is embedded in their context of practice (Essén & Värlander, 2018).

Technology adoption is a long-term process, and new digital devices interact with existing collectively accepted practices (Essén & Värlander, 2018). When a collective-frame changes, professionals develop *'new meanings and practices associated with new/emerging material artifacts'*, and such meanings *'come to be defined, accepted, gain traction, and may potentially even force revisions in extant logics'* (Purdy et al., 2017:415). Therefore, the introduction of digital devices and the development of digital infrastructures for public sector auditing are expected to be collectively negotiated over many years and to become entangled with existing audit practices.

Introducing and discursively supporting digital artifacts implies that professionals and other stakeholders are interpreting and negotiating the use of such digital artifacts in daily interactions, shaping a collective meaning system (Cornelissen, & Werner, 2014). Such processes will solidify and institutionalise the practice and the associated usage of the devices for a specific purpose (Gray et al.2015). For instance, Essén and Värlander (2018) discuss how regulatory agencies and the life science industry, ICT developers and rheumatologists have accommodated incoming technology into their dominant practice enacting an emergent frame of patient-centred care. Depending on the emerging meaning system, the artifacts that people use (and interact with) will afford their conversational practices differently, thereby impacting their shared understanding (Stigliani & Ravasi, 2012). Therefore, the materiality of digital devices is immersed in dominant practices *as* collective meaning systems.

2.1.Digital devices affording users: previous research evidence

When people (e.g., auditors) and computer devices interact, each one is a source of agency or a *'capability to engage in intelligible encounters'*; however, despite being goal-oriented, humans *'might only realize a limited repertoire of tasks'* (Pentzold & Bischof, 2019, p.1). Such agency to run tasks and activities, and to decide on and judge contextual

information, is distributed between humans and the digital devices in place. Murray et al. (2021) offer a taxonomy of the distribution of agency when humans and computers interact based on the role electronic devices play. When assuming a role complementary to humans, some technologies assist professionals in their routines (Murray et al., 2021) such as Excel spreadsheets. Individuals use the interface of digital devices to execute tasks, sometimes dealing with large amounts of data. These augmenting technologies (e.g., machine learning tools or data visualisation) provide recommendations for problem-solving tasks (Murray et al., 2021), thereby playing an automating role that replaces lower-level human skills with computer-based scripts.

Delegating agency to the scripts or algorithms embedded in computer devices may change the source of affordance from the interface to 'hidden rules'. The affordance may come from the outputs delivered by the automated process (i.e., affordance by interfaces, such as printed or online reports, analysis, warnings) (Pollock & D'Adderio, 2012); however, the hidden scripts of the digital device may also play a role (i.e., affordance from hidden rules). Following, we describe previous discussions on affordances from the interface and hidden rules of digital devices.

Affordance by interfaces. When users interact with the interface the device affords the practice by drawing individual attention or restricting the choices available due to restrictions imposed at the interface layer. Data visualisation, red flags, and rankings are performative, as they draw individual attention to some subjects (Salijeni et al., 2021); moreover, prefilled data entry masks also forge specific boundaries for acting (Pollock & D'Adderio, 2012).

> *Data visualisation.* Data visualisation techniques are interactive computer-supported exercises based on *'visual representations of data to amplify cognition'* (Dilla & Raschke, 2015:3); they are used to generate insights (Chang & Luo, 2019) or search for unusual patterns in a complex data set (Pollock & D'Adderio,2012; Salijeni et al., 2021). They comprise representation tools (to convert tabular representations to graphs or to highlight patterns) and data selection tools (to select and filter data) (Dilla & Raschke, 2015). The design of the data visualisation techniques affords how users will explore queries, graphs, and other visual elements to judge audit evidence (Dilla & Raschke, 2015; Rose et al., 2017).

> *Alerts, rankings, ratings, and indexes.* Such devices present a reduced perspective on the attributes of objects. Alerts notify individuals when an occurrence violates some expected condition, such as *'when account balances are outside the range considered acceptable'* (Salijeni et al., 2021:547), and by calling attention to them rather than to occurrences that do not match such conditions (Debreceny et al., 2003). For instance, 'automated red flags' risk auditor scepticism in the private sector (Barr-Pulliam et al., 2020). Lists or tables of rankings use ratings, indexes, and other calculative practices and reduce users' overall perspective of the evaluated objects (Pollock & D'Adderio, 2012). There are critiques of the pervasive and improper usage of rankings (Boedker, Chong, & Mouritsen, 2020). Users do not access the raw data and are rarely aware of the calculation rules of data aggregation and classification.

> *Prefilled data entry masks.* Entry masks or input masks are web/desktop formularies with a predefined set of input fields. They carry, by design, standard

values, unities, lengths, and contexts for each entry field, facilitating data entry for the user and allowing the standardisation of datasets, as they control the entry of data in a uniform manner (regarding data type and properties) (Huang & Vasarhelyi, 2019). However, they also impose constraints, such as limits on words to be filled in web/desktop formularies. Entry masks are often populated automatically with data, therefore potentially afford the user by the type, order, and aesthetic aspects of the formulary but also due to the level of prefilled information involved. Input masks forge specific boundaries for acting (Pollock & D'Adderio, 2012), and prefilled fields induce behaviour, as pointed out by studies on tax compliance (Fochmann, Müller, & Overesch, 2021).

Affordance from hidden rules. Algorithms, scripts, and dataset architecture are not at the devices' front end. Such rules are embedded, and their performativity is hidden but still present.

Algorithms and scripts. Often criticised for their opaque nature (Raisch & Krakowski, 2021), these are computational tools that specify the precise sequence of steps required to solve a problem, thereby augmenting and automating practices or routines (Glaser, Pollock, & D'Adderio, 2021). Operating outside the user's perception, algorithms and scripts carry power relations and expectations from their promoters (Glaser et al., 2021), for instance, the rules drive routines for specific tasks or problem-solving (Kitchin, 2017). Regarding the tasks run by such automating devices, auditor agency is reduced; however, the auditor is afforded by script outputs such as the red flags, tables, and ratings delivered by notifications or in dashboards.

Dataset architecture. Data visualisation depends on preselected representations of and limits on available information (Dilla & Raschke, 2015). The auditor, under availability bias, tends to economise time and effort in information acquisition and processing. The available datasets act as assisting artifacts and indirectly afford the auditor, as they define the boundaries of data analysis using the available dataset (Chang & Luo, 2019).

3. Methodology

To explore how digital technology affords auditors' remote audit practices we applied a qualitative research design based on multiple case studies relying on semi-structured interviews and documents. Brazilian Courts of Accounts present similar trajectories regarding how they historically developed their digital infrastructures. However, the data collection systems and CAATT are different in each Court, i.e., the context in which auditors relate to technology is different. Thus, a multiple case study allowed us to analyse and compare auditors' relationships with the digital infrastructure and understand similarities across cases.

We selected our cases via heterogeneous purposeful sampling, considering two criteria. First, based on the previous experience of the research team and the available literature (e.g., Aquino et al., 2021), we selected Courts that diverged on central aspects of their data collection systems and their digital infrastructure at work. Second, we looked for auditors with varying levels of job experience, as different levels of experience might reflect varying reliance levels on these systems. Appendix 1 shows that one-third of the participants have more than 10 years of experience as auditors, while the remainder are less experienced.

Data collection. We ran 39 interviews with auditors (lasting from 20 to 110 minutes), totalling 30 hours of videoconference-based interviews between May and November 2020. We reached saturation and stopped interviews when no more new insights emerged from participants as their answers became similar. We proceeded to the literal transcription of all the interviews. To gain access to the field, we departed from previously established contacts with auditors and increased access to other respondents via snowballing technique.

We informed all participants about the research objective and assured their anonymity, renaming the participants in the transcription phase. All auditors provided authorisation for the interviews to be recorded.

Auditors were asked to describe how they perform their tasks (looking at how they interact with the digital infrastructure). We relied on a semi-structured protocol to guarantee comparison between cases. The protocol covered: (i) a brief description of the data collection processes carried out by the Court; (ii) how auditors use CAATT applications, if available; (iii) how audit tasks were planned; (iv) how auditors access the collected dataset; and (v) aspects of training on digital applications, including CAATT and data collection systems. Each of the authors interviewed different auditors from the same Courts (i.e., interviewer triangulation) and used probing questions to capture how auditors interact with these systems.

Regarding documentary sources, we collected data available on the websites of the selected Courts, as official documents (e.g., data collection system layouts, handbooks for auditees operating the systems), news, and YouTube videos dealing with the digital infrastructure. During the interviews, some auditors shared the interfaces of the dashboards they operate and, although we did not have permission to publicise them, they were helpful in our analysis.

Data Analysis. We used narrative analysis techniques to connect the audit practices and use of CAATT, as the auditors described how they perform audit tasks through digital tools. The interview transcriptions were a guide rather than definitive materials; we returned to the audio recordings and documents recursively.

The coding process started with open and preliminary coding (Charmaz,2006) looking for digital affordances (i.e., data visualisation, prefilled data entry masks that shape auditors' practice). Following that, we agreed to a set of iterative rounds of focused coding (Charmaz,2006) observing how the remote audit frame communicates to the auditor how their goal-oriented tasks will interact with the features of the available digital tools. The rounds of analysis included returning to transcriptions and informal talks with auditors until we reached the saturation of the codes. By reconstructing such narratives, i.e., finding an implicit order between chronologically connected events, we clarified the possible interactions between auditors and the overall digital infrastructure in which they are embedded.

4. The collective-action frame of remote compliance auditing in Brazil

This section details the emergence of shared meaning (Essén & Värlander,2018; Gray et al.,2015) concerning remote compliance auditing in the Brazilian governmental auditing context. The dominant frame of remote compliance auditing by Courts of Accounts in Brazil and its core practices can be characterised by: (i) data being uploaded by the auditee to the audit organisation; (ii) validation rules aiming to increase data integrity (via entry

data controls); (iii) the stored data being the main material for audit evidence; (iv) auditors accessing the data-set through visualisation tools and relying on predefined warnings; and (v) a deeply shared understanding that data-driven auditing is a best practice. The core practices linked to the dominant frame are similar in all Courts, despite practice variations in peripherical aspects (Aquino et al.,2021).

The roots of remote compliance audit. In Brazil, there are 32 autonomous regional Courts of Accounts (hereafter Courts); they are public audit organisations with legal mandates to carry out financial, performance, and compliance audits for states and local governments (Lino & Aquino, 2018). Despite such a broad mandate, the Courts historically focus on compliance (i.e., legality) audits (Azevedo & Lino, 2018), including the oversight of budgetary fiscal ceilings (Azevedo & Lino, 2018). The 2000's Fiscal Responsibility Law demanded continuous monitoring of the fiscal and budgetary ceilings of local governments by the Courts (Aquino et al,2021). This continuous monitoring resulted in a substantial increase in the volume of transactions to be analysed and audited in shorter periods - something not feasible to be handcrafted as it depended on time-consuming taskforces. Thus, it ended up reinforcing compliance auditing frames among members of the Courts.

Responding to regulatory demands and searching for efficiency gains and cost and time savings, Courts started to collectively develop data collection systems to be used in audit practices (Aquino et al., 2021). Data collection systems are digital applications in which local governments (auditees) mandatorily upload the data stored in their financial management information systems (FMIS) to be subsequently analysed by auditors (using CAATT), thus providing the basis for remote auditing (Teeter, et al., 2010). The roots of the remote audit frame are linked to the increasing volume of data collected by data collection systems. Today, remote compliance auditing is seen as a best practice, as one senior auditor mentioned:

> *Our main recommendation for auditors is 'if you can do it remotely, do it'. Because it is cheaper. […] So, if you can do a good job with high-level assurance standards and you can do it remotely, that's perfect.* (Interviewee 19)

Following this, remote auditing became the norm and replaced virtually all on-site auditing (Azevedo & Lino, 2018). The frequency of interaction between auditors and auditees is reduced, as auditors regularly interact only with CAATT tools.

> *As a rule, [in the past] we used to go out into the field […] but [now] we are going out to the field less and less.* (Interviewee 2)

The development of digital infrastructures to support remote compliance audit. Data collection systems are not static; they evolve over time based on the Courts' increasingly informational demands. Accordingly, it increases the volume of data collected. This creates a cascade effect. On the one hand, whenever new data are collected, the Courts might invest in new CAATT modules to analyse the enlarged dataset. On the other hand, local governments' FMIS are continuously changing to cope with the requirement to upload their data following the data entry masks of the data collection system (Lino et al., 2021).

In effect, for each Court, a digital infrastructure (Fürstenau et al., 2019) coevolved from FMIS and CAATTs orbiting and connected to the boundaries of the Courts' data collection system (Aquino et al., 2021). Figure 1 represents the process of a remote compliance audit (data-driven audit) through the typical digital infrastructure of a Court. The data collection system is at the centre of the infrastructure. The FMIS of audited local governments is connected at the downward boundary. At the forward boundary are the modules linked to the computer-assisted audit tools used by auditors engaged in remote audit practice in the Courts.

Figure 1 – Backward and forward boundaries of the public audit digital infrastructure
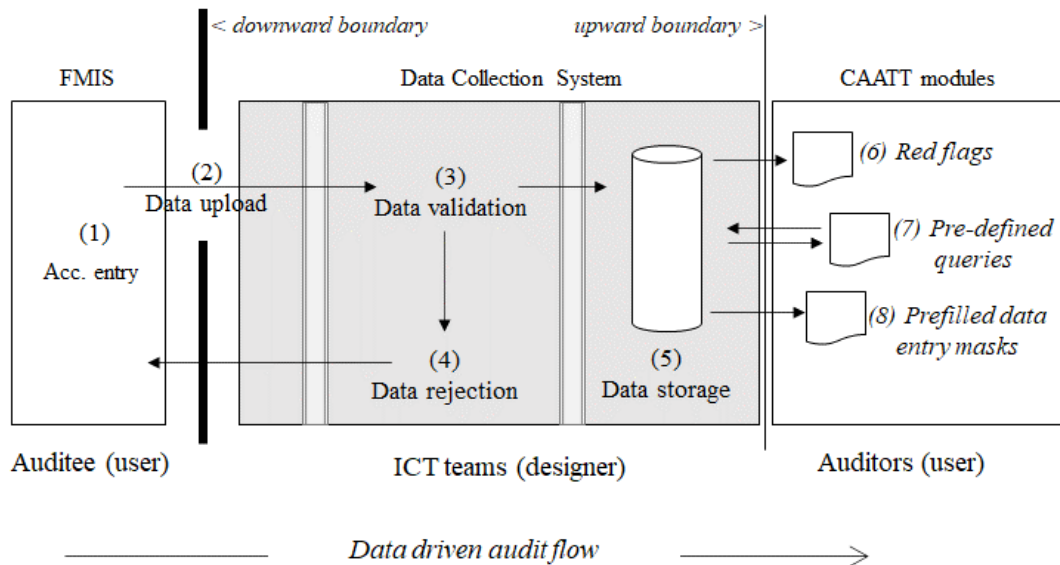
All these systems are designed by ICT teams (outsourced in some Courts). Both auditees and auditors are unaware of what we call the digital infrastructure's backstage – the ICT designer's realm. The backstage is a relational space in which ICT teams responsible for the automated routines and rules manage the hardware and software networks and cloud storage. Thus, whenever the auditor interacts with CAATT, s/he is – in fact – interacting with digital tools connected to the broader digital infrastructure. The digital infrastructure and its data flow act as a material carrier for the newly emerging practice.

Digital infrastructure as a platform of interactions: where technological and collective-action frames connect. In the early 2000s, remote auditing practices in the Brazilian public sector were shaped by how leading auditors and (at that time) a few ICT specialists interpreted the demands and opportunities arising from technological advancements (e.g., high-speed internet, the commoditisation of hardware and storage technology, and the use of FMIS by auditees).

Leading auditors from Courts collaborated in at least two sets of actions linked to the development of digital infrastructures. First, they attended a development program funded by the Inter-American Development Bank dedicated to pushing the technology of the Courts forward. The program, named Promoex, created a shared meaning regarding how the Courts would implement innovations related to audit tasks (Lino & Aquino,2018). Second, after Promoex, the leading auditors within the Courts collaborated by sharing their proprietary systems, offering mutual support, and sharing motivating strategies

when they went ahead with using data collection systems in Brazil and as computational resources started being used by auditees.

The emergence of remote audit is fully associated with how leading auditors interpret the challenge of continuous audit and how the new technology could be used to implement this practice and ended up shaping the emerging digital infrastructures. The Courts converged in homogenous trajectories and agreed on how to use and implement digital technology, thereby generating a dominant collective understanding of remote auditing. In general, there are positive expectations regarding the use of digital artifacts due to their promise of saving time within a high-pressure environment:

> *The major advantage of using a system for data gathering, processing, and visualisation is [...] time, right? You save time; that is a fact. [...] If you do the same task in software like Microsoft Word, it will take a lot of time. [The CAATT device] gives you the advantage of saving time on a large scale [... by] interacting with other systems.* (Interviewee 3)

This shared understanding led to increases in the scope and volume of collected data, which propelled the institutionalisation of remote auditing (Aquino et al., 2021). The digital infrastructure orbiting around the data collection systems (which was initially a solution to the challenges of continuous monitoring) became the platform for audit practice: it connected multiple stakeholders in the many stages of remote audit practice. As stakeholders (accountants, software suppliers, ICT helpdesks in Courts, and auditors) interacted during entry data, storage, data visualisation and prefilled fields in reporting, they continuously negotiated and institutionalised meanings (Cornelissen & Werner, 2014) and agreed on how the audit practice should be conducted in present (and future).

In recent decades, there has been an amplification and extension of the remote auditing frame. Especially for new auditors, who have taken up their positions after remote auditing was put in place, remote auditing is a practice that is taken for granted, and auditors depend on the information retrieved from municipalities. One remarkable statement from an auditor is that *'if the municipality does not upload the information [into] the system correctly, we are blind'* (Interviewee 1). Auditors remotely interact with auditees via data visualisation tools, and they believe that this is the best way to cope with audit demands. One auditor stated, *'Imagine how long it would take to do that audit task without the CAATT?'* (Interviewee 5).

The materialisation of the collective action frame on the data flow of remote compliance auditing. The data flow comprises the typical data processing cycle, which is made up of input (e.g., data entry, loading data into the system), process (e.g., analysing and summarising data), and output stages (e.g., results of data analysis, such as data visualisation tools) (Huerta & Jensen,2017; Rose et al.,2017).

Due to the frame negotiated and constructed over time, the data flow of the Courts' digital infrastructure follows an identifiable pattern (Figure 1). The process starts with governments running their FMIS to automate journal entry routines, transaction matching, account reconciliation, and reporting (1). Then, government accountants extract data from the FMIS to upload datasets to the Court's data collection system (2). The reporting follows the Courts' reporting agenda, predefined layouts (e.g., reporting templates), and adopts the required data specification (e.g., csv, xml, xbrl). In the following step, the data collection systems run automated data validation to verify the data's consistency (3). Some Courts use more than 1,000 rules to check the accounting and fiscal data's consistency. For instance, validation rules check whether an employer

number (a.k.a., federal tax identification number) in a contract is valid. Rules analysing if the monetary values in the last financial statements correspond to the opening values of the next term are another example. Inconsistent data are rejected, and corrections are required before a new upload can be made by the auditee (4).

The validated data are stored (5) and made available to CAATT applications at the upward boundary of the digital infrastructure (6, 7, and 8). This remote audit mainly comprises data analysis over the storage data (Huerta & Jensen,2017) as data visualisation queries, automated red flags, and reporting data entry masks – all examples of CAATT modules. The modules are often jointly accessible to auditors through a typical dashboard or generalised audit software.

5. Digital affordances framing audit practices

This section highlights some devices at the forward boundary of the digital infrastructure that afford auditors according to the negotiated remote auditing practice in place

The digital infrastructure of each Court is comprised of several material artifacts which exert diverse types of affordances on the humans interacting with the infrastructure. As aforementioned (Figure 1), the ICT team interacts before and after the upward boundary by designing the infrastructure's backstage and the CAATT modules, while auditors interact with the CAATT as users. Thus, the CAATT – as the forward boundary of the digital infrastructure in which auditors interact with the collected datasets – materialises multiple previous decisions on the design of the digital infrastructure; these affect auditors' behaviour and practices, thereby shaping their actions.

Table 1 correlates the affordance from the interface of three CAATT devices with the affordance from the hidden rules of the digital infrastructure; it shows how the CAATT distributes agency between the digital devices and auditors.

Effects of the hidden rules of the digital infrastructure: scripts and available datasets. All CAATT devices operate based on the collected data, i.e., the available dataset. Every decision on the dataset architecture, scripts, and algorithms will affect the outputs of auditors when using CAATT (Chang & Luo,2019; Dilla & Raschke,2015; Glaser et al.,2021) and will jointly afford the auditor's use of the system shaping the audit practice. The dataset's architecture, scripts, and algorithms afford auditors via their hidden rules (in the infrastructures' backstage), and affect the devices used by auditors in the form of red flags, data visualisation, and prefilled data entry masks for reporting.

The dataset architecture, scripts, and algorithms of Brazilian Courts are the realm of data-scientists or engineers. Auditors are usually not involved in the design of the digital infrastructure's backstage. Therefore, part of the agency involved in the audit process has been transferred – by design – to ICT teams, and it is shaped by their choices regarding the dataset architecture, scripts, and algorithms.

The agenda towards enlarging the data to be collected from auditees defines the 'available dataset' which comprises all information ready-for-audit-use. The Courts vary on how hard they have pushed forward the coverage, frequency, and granularity of collected data during the last 20 years (Aquino et al., 2021). Usually, Courts launch versions of their data collection systems that are valid for a couple of years (Aquino et al.,2021). In Brazilian remote auditing, because auditors are not in charge of extracting data from the auditees' FMIS and rarely collect data by themselves, technology assists in the process;

data entry masks, communication protocols, scripts, and algorithms in the digital infrastructure's backstage automate the data entry process.

Table 1: Sources of affordances on auditors' actions

CAATT devices >	Red flags	Data visualisation	Prefilled data entry masks
Hidden rules effects: scripts and the available dataset	*On warnings* Red flags operate only on the available dataset; scripts automate the warnings	*On queries* Queries are constrained by the available dataset; scripts automate the queries	*On indexes' composition* Scripts automate the indexes and prefill fields based on the available dataset
How affordance occurs	By type, frequency, and volume of warnings received by email and how they are made available in the dashboard	By set of predefined queries, position of menus, and rankings of selected performance measures in the dashboard	By set of fields, order of covered subjects, prefilled vs. open fields in the webform
Auditors' declared awareness about the affordance	CAATT usage may legitimise the reduction of onsite auditing	The auditor requests access to raw data or make additional queries	The auditor adds additional evidence into the final report (ignored by magistrates)
Distribution of agency	Technology arrests auditor's agency	Technology augments auditors' agency	Technology assists/automates auditor's agency
Remaining auditors' agency	Arrested by warnings to look at the accumulated evidence indicating locus of action	Auditors use data visualisation based on available data	Auditors justify the predefined indices and fill in the blanks
Source of material agency (Figure 1)	Algorithms and scripts running on the data stored	Data visualisation engine and front end of dashboards	Data entry fields and masks at the front end of CAATT modules

Sources of affordance: (i) in columns the affordances at CAATT interfaces: Red flags; Data visualisation; Prefilled data entry masks; (ii) in the first line the affordance from hidden rules: scripts and the available dataset. The two forms of affordance emerge conjointly in the audit task.

The dataset storage in the backstage is the same for all auditees of any Court, and any auditor has the same set of data for all auditees within that period. Auditors' agency is restricted to requesting new information and suggesting improvements to the dataset to be implemented by ICT teams, who are often not responsive to auditors:

> *There is no way to ask [for additional information]. We rarely get in touch [with] our ICT team; when we don't have the data, we just will not have it [laughs]. [...] It is possible to ask them [ICT teams] to implement new data entry, but it will take time and we don't know how long it will take.* (Interviewee 26).

Second, the scripts and algorithms implemented by ICT teams translate the fiscal and budgetary rules imposed by financial laws and valued by magistrates from that Court. Despite the same laws applying to fiscal and budgetary monitoring in Brazilian states and municipalities, each Court operationalises the regulations according to its own interpretation and selects a set of indexes to use.

Red flags. As a typical concurrent monitoring technique, the CAATT sends alerts by email or to the auditor's dashboard, to notify them about identified inconsistencies. This is an automated feature that verifies when transactions or data breach some predefined rules or thresholds (Dai & Vasarhelyi,2016; Salijeni et al.,2021). This device affords the auditor through the frequency and order of the alerts delivered by the system; it also influences them through the hidden rules in the scripts and dataset architecture. The alerts are delivered when any inconsistencies are detected; they are collected in an email inbox or in a list of alerts on the dashboard. For example:

> *Every day, [at]5:00 A.M., our system sends an email to the auditor. If there is a procurement process with any suspect of misconduct [...] the auditor already knows [at] 5:00 A.M [...].if the municipality [s/]he is working with has a process or any contract that need[s] further analysis.*(Interviewee 24)

Typically, the CAATT uses colours to target some specific meanings and actions for the auditor.

> *The system shows on the homepage all the auditees, using specific colours, [so] I know which of them submitted their documents on time or not. If I move the mouse to these circles [showing on the screen], I know whether the auditee's report was sent on time or not. [For example,] the red colour indicates the deadline is overdue. The colour gives me a hint that I need to check that auditee more closely since it is not compliant.*(Interviewee 32)

Despite the auditors recognising the utility of the automated alerts (Salijeni et al.,2021), none of our interviewees showed concerns about potential problems not covered by the dataset or by the scripts. It seems that the hidden rules for automating the red flags were unnoticed.

Data visualisation. The dashboards prepared for the auditor offer predefined visual representations of data, including queries, graphs, and pivot tables, along with lists of relevant

transactions, accounts, and a mailbox of delivered alerts (red flags). The elements on the interface will jointly afford the auditor. For instance, auditors can drill down and up data, but only on the variables and periods available for data visualisation. The interface affords the auditors and how they will articulate expertise to get evidence from data (Dilla & Raschke,2015; Rose et al.,2017). More than that, hidden rules impose boundaries and change how the interface will afford. For instance, the CAATT's design – including scripts and algorithms of queries, the ordering of information (e.g., only top-10 transactions showed on-screen), and the dataset available for queries – strongly influence the auditor (availability cognitive bias, Chang & Luo,2019).

Such tools support auditors by synthesising distinct data dimensions and a high volume of data; for instance, when exploring evidence regarding the red flags they have received. Auditors perceive that there are benefits related to planning audit tasks:

> *When planning the audit task for a municipality, I start looking for all [the] financial reports prepared by our system [CAATT]; for instance, the named 'digital annual analysis'. Such [a digital] report offers 'ready-to-use' analysis covering plenty of information for that entity, including budgetary and financial performance.*(Interviewee 5)

The auditors could proceed by looking for hidden patterns, outliers, and anomalies in the data they analyse; however, they remain restricted by the limits imposed by data visualisation parameters. In interviews, they showed no willingness to explore more data than the predefined data queries. Moreover, auditors do not demand access to auditees' raw dataset. In general, auditors are not data analysts: they find it difficult to operate business intelligence applications, and therefore Courts have few commercial licences used by experts – the remaining auditors use preselected queries in their dashboards. They are first-level users who value saving time (Gray & Debreceny,2014) and do not realise that this comes at the expense of professional judgment, resulting in overconfidence and overreliance on data visualisation tools (Chang & Luo,2019).

> *I can build on our visualisation module, queries, and tables. It is flexible; I can explore the information as I prefer. But there is a predefined 'ready-to-use' report. Basically, I navigate through the standards sheets and find about 90% of the information I need, or even more. Then we do not need to search for anything more, we just need to use the data.*(Interviewee 2)

It is expected that the humans interacting with data visualisation tools exert agency to amplify the benefits associated with their use; for instance, amplified cognition (Dilla & Raschke,2015), insights (Chang & Luo,2019), and detecting patterns (Rose et al.,2017). However, our interviewees perceive low value from such tools. ICT teams regularly launch new functionalities which are not necessarily immediately incorporated into the daily routine of auditors, as one interviewee confirmed:

> *I'm getting to know now [about the CAATT features] while I am speaking to you [...] I never used it. Perhaps it has many resources that we are not aware of, that if we knew more, it could help [our audit tasks].*(Interviewee 5)

Such a context combined with remote audit does not produce the expected benefits of the new dominant audit practice; meanwhile, it might result in overconfidence, anchoring, confirmation, and availability cognitive bias (Chang & Luo,2019).

Prefilled data entry masks. These are semi-editable electronic formularies (text files or HTML interfaces) comprising a set of: (i)semi-editable text fields and (ii)prefilled-numerical fields which assist auditors in reporting their audit opinion. While prefilled fields are automatically calculated indexes based on budgetary and fiscal ceilings, semi-editable text fields can be used by the auditor to justify and explain the audit opinion.

This device affords the auditor through the formulary mask (e.g., the type, order, and aesthetics of the formulary) and through the level and type of the prefilled information. In effect, it drives which indexes should be considered to compose the audit opinion. There are also hidden rules from scripts and dataset architecture, as the indexes are also composed by scripts running on the available dataset. Therefore, auditors are driven to offer an opinion within the boundaries set by the formulary and its prefilled fields.

At first, entry masks in reports appear to have a positive impact; they provide standardised, minimal, and ordered content that can be filled in for all auditors in a particular Court. However, auditors argue that entry masks prevent the audit opinion from varying significantly for similar cases. There is also an incentive to keep reporting to a minimum level due to the overload of audit tasks. One interviewee described an anecdote about an auditor concluding his opinion without any professional judgment:

> *There is a data entry mask for reporting here at the Court. The formulary comprises the topics that the auditors must fill in. For example, there is a table with predefined rows and columns to be filled in. Basically, the auditor just needs to copy and paste data from other systems [CAATT].*(Interviewee 26)

The material agency comes from the designed formulary mask, which prevents the auditor from writing the reports freely, and from the pre-selected indexes. Similarly, prefilled data affords auditors to exert minimal cognitive effort. In ways, the auditors perceive that their agency is constrained. Assistive technology may act as an automating one, as it severely limits the auditor's choices. One extreme example is that of a north-eastern state where a Court implemented full automation for reporting lower-risky transactions; thus, the audit opinion no longer cover such transactions. However, auditors vary regarding their scepticism about the use of prefilled indexes. Some auditors perceive prefilled indexes are beneficial as they save time and avoid errors when calculating fiscal and budgetary indexes and thresholds (due to changing interpretations of laws and regulations). We observed that for novice auditors trained in using CAATT modules as part of the remote auditing frame, the automatic filling in of data to prepare their opinion is taken for granted. Senior auditors, though, remember audit practices before remote auditing, and such automated features prompt scepticism. Some of them are highly critical and see constraints imposed by the reporting mask as they "*cannot select the content of the report nor customise it*" (Interviewee 26).

Depending on the auditor's background (e.g., accounting or law) and expertise, they might explore different audit evidence. Some auditors claimed when trying to add additional evidence to support the final report, the Court's upper layer (Magistrates) ignored the additional analysis. This indicates that auditors are expected to comply with the prefilled fields; thus, the ability to

use this technology to save time that can instead be dedicated to cognitively complex tasks such as identifying relevant information that can support auditors' judgment (Brown-Liburd et al.,2015) is not valued at all.

6. Discussion and implications

Our study discusses how a set of digital infrastructures maintained by each Court in Brazil is thoroughly entangled with the emergence of remote practice in compliance auditing. CAATT modules, and the scripts and algorithms in the infrastructure's backstage, materialise and reinforce the frame of remote auditing practice. The data collection systems continuously developed by ICT teams reinforce the construction of large data sets from the auditee's data uploads and reinforce validation rules as the guardians of data integrity. Therefore, the stored data becomes the primary material for audit evidence. Consequently, auditors are pushed to interact at the forward boundaries of the digital infrastructure via the existing CAATT modules developed by ICT teams.

We offer a threefold contribution to the literature. First, relying on a Napoleonic audit model, we cover digital transformation and the introduction of digital devices in public sector auditing. Second, we explore how the affordance of digital devices is connected to audit practices (and wider collective frames) and how these ultimately constrain auditors' agency while at the same time empowering ICT teams in such organisations. Finally, we provide evidence on how digital devices may obstruct auditors' professional requirements, such as scepticism.

First, despite practitioners increasingly recognise the importance of digitalisation of public sector auditing – as evidenced by INTOSAI's Moscow Declaration (INTOSAI,2019) – extant literature on public sector auditing overlooks this issue (Mattei et al.,2021). By highlighting the collective frames that have emerged, and which support the introduction of technology to shape governmental audit practices in the Brazilian context, our study corrects this lack of understanding of the impacts that stem from technology adoption in public sector auditing. Exploring the Courts' model of public sector auditing, where compliance auditing is more prominent than performance auditing, the collective frame and affordances stemming from digitalisation reinforced exactly a remote compliance auditing. This opens opportunities to compare how the processes involved in the digitalisation of practices in the 'Board' and 'Westminster' models (Hay & Cordery,2021) differ from the introduction of digital devices in a Napoleonic audit setting –since different audit types are more relevant in each model of public audit organisations (e.g., compliance vs. performance auditing).

Second, our findings show that the introduction of digital devices is a process dependent on users negotiating a collective frame over time. Infused with meaning derived from the collective frame, CAATT devices (e.g., red flags, data visualisation, and prefilled data entry masks) afford auditors' practices – and seemingly constrain their agency while ICT teams are empowered since they design the digital infrastructure's backstage.

The way in which the digital infrastructure established by the Brazilian Courts was implemented over the years was linked to existing audit practices guiding ICT teams in developing digital devices (Cornelissen & Werner, 2014). The interactions of users and promoters of technology drive how pre-existing compliance audit practices were smoothly incorporated into the CAATT devices over many years. This process was developed to monitor budgetary and fiscal ceilings enacted by the Fiscal Responsibility Law. Thus, although one may

expect some degree of innovation to emerge from the use of such technology in auditing (Salijeni et al.,2021), in effect the core aspects of audit practices have not changed in this case; for instance, compliance auditing is still a foundational work practice within Brazilian Courts.

The introduction of digital devices in audit practices, when collectively accepted, is done without fanfare, and auditors do not fully perceive how their practices have been affected as a result. Like Essén and Värlander (2018), we observe that a conjoint materiality act on auditors. Auditors perform audit practices while not necessarily acknowledging what happens behind the CAATT interface; for instance, they do not necessarily distinguish between parts of the digital infrastructure when interacting with the many devices in the CAATT interface. This is like a person looking at the time on a watch but not realising that there is a mechanism keeping the watch running - as pointed out in the literature on scripts and algorithms (Glaser et al.,2021; Raisch & Krakowski,2021). However, we highlight the opaque nature of algorithms and scripts jointly operating with other devices, as discussed by Burrell (2016). Auditors are afforded directly by the CAATT interface but are also afforded by the ICT team's previous decisions regarding the dataset architecture, scripts, and algorithms – i.e., the backstage infrastructure.

Each CAATT device acts with varied levels of distributed agency. For instance, red flags are fully automated and arrest behaviour (Murray et al.,2021), thereby driving the auditor's attention to specific aspects of the dataset while not allowing them to take different actions – and even preventing them from acting – because they cannot alter the predefined conditions (scripts). Due to the increase in automated rules, auditors get overwhelmed by red flags, as they are required to analyse dozens of alerts per day; this brings inefficiencies into the audit process (see Alles et al.,2008). In sum, red flags' scripts are designed and implemented by ICT teams, carrying potential inconsistencies or anomalies, enacted when operated by the auditor. Digital visualisation augments cognition; however, similar to Murray et al.,(2021), when auditors blindly follow the output from such augmenting technology, inappropriate audit conclusions may emerge. INTOSAI's (2007) already raised a concern about auditors relying exclusively on the data analysis rather than using non-computer-based audit tests to provide corroborating evidence. Both red flags and digital visualisation may shape auditors' attention. The alerts end up working like a GPS system in which the driver does not notice details on the road around him and instead focuses only on the indicated route. Finally, although prefilled data entry is appreciated, as it saves auditors' time and makes audit conclusions more comparable (Salijeni et al.,2021), at the end of the day it reduces their agency, as they their voices are withdrawn from the process of reporting.

As the audit work occurs, many conjoined affordances are in place, and agency is distributed between auditors and multiple devices (and to ICT teams responsible for the design phase of the infrastructure's backstage and CAATT modules). For instance, as the data are validated when uploaded by the auditees, predetermined scripts validate just the data previously defined as the ones that must be audited. In effect, auditors end up being influenced in their routines by: (i) the architecture of the data and (ii) the belief that the data sent by the auditee has full integrity, which reduces scepticism regarding the data.

Auditing organisations must be aware of the effects of the use of technology and avoid the consequence whereby auditors are turned into mere 'audit system users'. This situation would be different in another form of digital infrastructure; e.g., when auditors directly access transactions and databases of the auditees without relying on a data collection system to act as an intermediary in the process.

Moreover, since affordances are goal-oriented, the ultimate goal of the type of audit task being performed (compliance audit, performance audit, financial audit) matters to how devices would afford auditors. As public audit organization focus on different types of audits (Hay & Cordery, 2021) the affordances from similar digital devices may vary in comparative research. Such variance would emerge from the collective frame linked to the dominant type of audit in place in each country.

Our third contribution to the literature raises concerns about the effects of digitalisation on audit scepticism –often debated in private auditing settings (Nelson, 2009). Digital devices seem to reduce auditors' scepticism, and may empower ICT-related teams in such organisations. The decrease in scepticism occurs due to the acceptance by auditors of the status quo promoted by the digital frame. For instance, as auditors accept the remote validation process and the data under analysis have already been previously validated by the data collection system, they tend to accept the data without question. Similarly, as the digital infrastructure is part of a collectively accepted practice, the absence of certain information directs auditors' attention only to what is available; after all, the relevant data was selected at the design of the digital infrastructure. Although positive effects linked to the digital infrastructure are to be found (Davenport, 2018, Salijeni et al.,2021), we point out that as new practices are implemented, they push auditors to merely act at the forward boundaries of the remote auditing process, which may reduce autonomous auditing. At the same time, because ICT teams are mandated to decide on the dataset architecture, the boundaries of audit tasks prevent auditors from running analyses of transactions, periods, and accounts not covered by the architecture.

When following the established collective action frame, auditors take for granted that remote audit is best practice; they accept and do not question the fact that they work only with part of the relevant information and that sets of data are not prepared on a case-by-case basis but instead based on a past ICT decision. The remote auditing frame is continuously reinforced using CAATT devices such as dashboards, alerts, and prefilled formularies; this gives auditors the impression that the validated data are sufficient for good audit practice.

As a result, the introduction of digital devices in public sector audit practice will also challenge the status of public sector auditors. The remote auditing frame may be *weakening the audit profession* in the public sector and reducing auditors' autonomy and scepticism (Barr-Pulliam et al., 2020; Hurtt et al., 2013; Nelson, 2009). Still, it is not clear whether autonomy and scepticism silently melt into audit practice. The agency of governmental auditors in the Brazilian Courts is being continuously distributed to digital devices and to the designers of algorithms, scripts, prefilled data entry masks, and automated warnings. For instance, we identified a transference of audit planning choices to the digital infrastructure's backstage design (in the form of predefined queries and red flags) run by ICT teams. As mentioned, dataset architecture, scripts, and algorithms in Brazilian Courts are the realm of data-scientists and engineers. Auditors' autonomy is also reduced regarding how to introduce, organise, justify, and support the audit evidence, as auditors are required to use data entry masks in their reporting. The ICT teams now play a key role in Brazilian audit organisations. Auditors adopt a passive posture regarding predefined automated applications, which may reduce their professional scepticism. Failing to keep a so-called 'questioning mind' when evaluating evidence (Hurtt et al.,2013) is a concern in the auditing field (Durkin, Rose, & Thibodeau, 2019).

7. Conclusions

The introduction of technology is shaping the future of the audit process (Mattei et al., 2021) and attracting attention of public sector audit organisations, which are prone to introducing data analytics and new techniques in audit practices, as stated by the Moscow Declaration (INTOSAI, 2019).

The analysis of the Brazilian case reveals concerns regarding how the introduction of digital devices can unbalance remote auditing within the public auditing field when new digital infrastructures connected to the practices of remote auditing emerge and are collectively accepted and legitimised by government audit organisations. Our findings indicate that the construction of a collective frame generates assumptions that are taken for granted regarding the overall objectives of (compliance) auditing. As shown, when relying on this emergent frame, auditors are afforded by different digital devices, i.e., CAATTs' modules. To some extent, auditors are not aware of the scripts embedded in digital devices, and they become over-reliant on this type of data while losing sight of other forms of evidence that should be taken into consideration when forming their audit opinion.

The future of digital infrastructure for public sector audit organisations is a promising research topic. Following we identify avenues for future research. First, the interactions between auditors and data-scientists within audit organisations, and the increased use of digital devices, may change the boundaries of expected professional scepticism and autonomy. Reduced autonomy may potentially reduce auditors' feelings of meaningfulness at work and impact their self-identity, thus resulting in alienation and feelings of powerlessness (Stein et al., 2019). Therefore, the introduction of digital devices that shape audit practices may require actions towards a more proactive posture instead of one in which the constraints imposed by CAATT are passively accepted. Second, a comparative approach might analyse how the architecture of digital infrastructures varies. The implications for data-driven auditing might be dependent on the national context; for instance, some countries impose the same FMIS on all public entities (e.g., Peru); thus, the data can be directly accessed by audit bodies. In such a case, the digital infrastructure's core is the FMIS, rather than a data collection system. Finally, it should be noted that different affordances from digital devices might emerge in Westminster or Board model SAIs, since compliance auditing might not be the core activity performed by auditors.

Data Availability

The data that support the findings of this study are not shared or publicly available due to privacy or ethical restrictions.

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