Reengineering the audit in a digitized environment - developments in practice, challenges for auditing standards and opportunities for further research

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Submitted to the International Symposium on Audit Research 2014

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Summary

Auditing has evolved considerably over time. Started off with a fully substantive testing approach, auditing shifted to a risk based controls based approach throughout time. Current developments involving electronic data are now again creating a new era within the auditing profession. The profession is entering a singularity point.

Where auditing originally used simple computer assisted audit techniques, current process mining techniques and the use of big data are expected to significantly change the audit production process. Auditing theory grounded in The Netherlands some decades ago appears to revive as a result of this increasing attention for data enabled auditing. In this paper the authors visualize the path to further developments on the cutting edge of academic research, audit practice developments, and standard setting.

Key words CAATs, process mining, big data, model driven auditing, auditing standards, value cycle

Data availability

Not applicable

1. Introduction

Over the last decades information technology has increasingly worked its way through the 'way-of-working' of the auditor and has started to radically change his interaction with assurance information. Within the financial statements audit, the auditor not only encounters information technology as a subject of assurance, but also increasingly as an audit tool. This is reflected in an emerging role of data analytics within the audit practice. Data analytics refers to the evolved way in which auditors access assurance information in an era of data(fication)[2], digitization, data standardization, network- and system connectivity and unprecedented automated analysis and visualization capabilities.

Increasing data analytics experiences in practice start to raise questions about the effectiveness of traditional audit procedures within such a strongly evolved audit environment (Chan et al., 2011; AICPA, 2012). Some of the premises underlying these procedures seem to be no longer applicable to the current auditing context and seriously dispute the design of the audit as we have known it for decades (Vasarhelyi, 2013; Boritz et al., 2009). Where auditors make their first steps in redesigning audit procedures, they uncover several methodological issues and challenges for which current auditing standards not always seem to give sufficient hold (Zhang et al., 2012; Titera, 2013). Such 'grip' from auditing standards is necessary to facilitate and stimulate audit innovation in a historically strongly regulated profession (Vasarhelyi, Warren, Teeter and Titera, 2014)..

The attention for the use of electronic data in the current International Standards on Auditing (ISAs) is quite limited to ISA 330, where Computer Assisted Audit Techniques (CAATs) are mentioned as an alternative for audit evidence derived from other sources. For instance, CAATs are described to be useful '(…) to select sample transactions from key electronic files, to sort transactions with specific characteristics, or to test an entire population instead of a sample.' (ISA 330.A16). Furthermore, CAATs are mentioned in combination with controls testing (ISA 330.A27). The question is, however, whether the application of CAATs in specific ways and in and data analytics in general, as described in current ISAs, sufficiently covers contemporary (opportunities for) application in practice. Titera (Titera, 2013) opened the debate with 'The reality is that the current audit model does not adequately address data analytics, which falls in between analytical procedures and tests of details.' Consequently he urges the auditing standards to be revised in this

[2] Term firstly mentioned by Mayer-Schönberger and Cukier (2013). For definition, reference is made to page 9.

respect. This urgency for change is also reflected on the agenda of global standard setters. In the recently published proposed strategy for 2015-2019, the International Audit and Assurance Standards Board (IAASB) describes the developments regarding the use of electronic data as 'Consideration of emerging issues about audit evidence obtained through the use of sophisticated data analytics techniques, including the implications on the auditor's risk assessment and response, as well as the effect on the nature and timing of other planned audit procedures and the auditor's ability to obtain sufficient appropriate audit evidence' (IAASB, 2013, p. 40)'.

This paper explores the increasing role of data analytics within the financial statements audit, how these developments give rise to reengineering opportunities with respect to the traditional audit model and where the ISAs could support these innovations. The remainder of this paper is structured using these three angles. In chapter 2, we describe the latest developments regarding data analytics application in the financial statement audit from an academic as well as a practice point of view. Chapter 3 explores why the Dutch auditing tradition experiences a revival as a result of these developments. Chapter 4 mirrors the developments explored in chapters 2 and 3 to the need of revising the ISAs, followed by areas for further research in chapter 5.

2. Developments in data analytics application in financial statements audit

A series of information technology and data capturing developments have reshaped the business environment (Kogan et al., 2010; Alles et al., 2006) in such a disruptive way that – whilst undergoing the change process – these developments have already been labeled the 'Third Industrial Revolution'. Data, and the information that can be derived from it, are considered the new fuel of the economy (Mayer-Schönberger et al., 2013). Datafication, digitization, data standardization, network- and system connectivity (Hunton et al. 2003; Boritz et al., 2009) and the presence of technically and economically feasible analysis and visualization methods and tools, amongst others, have led the business world to an age of unprecedented data accessibility and interaction.

The emergence of data analytics application in the financial statements audit practice, but also the increasing attention for this topic within academia is the living proof of that.

Computer-Assisted Audit Techniques (CAATs)

The first generation of data analytics within the practice of the financial statements audit, also referred to as CAATs, was in its application primarily aimed at reducing manual (time consuming) evidence gathering procedures in the execution phase of the audit process. Auditors used in-house or third-party developed audit software with programmed risk indicators to gather evidence on predefined control objectives over financial statements line items, using mostly general ledger data in predefined formats relating to so called 'balances and flows'. This way of 'auditing with the computer' described the employment of technologies by auditors to perform audit procedures that would otherwise be done manually or be outsourced (Sirikulvadhana, 2002).

This first generation of CAATs application did not require significant remodeling of the audit process; it was about performing previously known audit procedures, using 'smart' tools. Initially, a primary consideration for auditors to apply CAATs in practice lied in increasing the efficiency of the audit process. The potential for increased audit effectiveness was most-certainly acknowledged, however tended to be addressed as a by-catch. The most mentioned benefit, in this respect, was CAATs' ability to enable efficient audit testing of a far greater or even whole audit population, compared to the traditional sample driven approach. A sample driven approach had long been the auditor's refuge in a time where obtaining access to analog assurance information was quite labor-intensive (Chan et al., 2011; NIVRA, 1982).

As CAATs developed along, it proved to offer a far more extended application throughout the audit process (Titera, 2013) than sheer automation of previously manual audit procedures and extension of the scope of an audit test. Over time, the ability of data analytics to create previously unavailable insights caught more and more attention. CAATs are, for example, able to generate certain cross sections of the general ledger, which provide an unprecedented level of information for the risk identification and scoping phase of the audit. In this example, such cross sections enable auditors to disaggregate all general ledger transactions into certain classes of transactions, based on risk indicators:

- Regular and expected transactions from unusual and/or unexpected transactions
- Routine transactions from non-routine transactions
- Controlled transactions from non-controlled transactions.

These analyses, again, constitute an extremely valuable source of information for the auditor to develop further audit procedures which appropriately match the identified risks of each class of transaction.

The examples can also be extended to other phases of the audit. Although the information underlying these new insights has always been latently present in the auditee's system, CAATs are able to provide auditors access to it in an efficient way.

Process mining

Process mining is a data analytics technique that has caught the attention of the auditing practice in recent years and which is aimed at obtaining relevant audit insights from the digital trails (derived metadata) that business processes leave in information systems. These metadata (aggregated 'event logs') have the potential to provide insight into the process and controls environment surrounding the earlier mentioned general ledger 'balances and flows'. According to Jans et al. (2010) "What makes an event log such a unique and potentially invaluable resource for auditing is not only that it provides the auditor with more data to analyze, but also because that additional data is recorded automatically and independently of the person whose behavior is the subject of the audit."

Process mining is applied in three ways (Van der Aalst et al., 2012):

a. *Process Discovery (without 'a priori' model)*
   Using data from information system event logs to reconstruct transactional flows and obtain information on the actual course of business processes, without having any other 'a priori' information.

b. *Conformance Checking (with 'a priori' model)*
   Comparing a business process design (intended) with a model created using event logs (observed) and identifying deviations.

c. *Performance Analysis (with 'a priori' model)*
   Identifying the frequency of patterns in transactional flows and using this information to change or extend the existing a priori model.

The application of process mining techniques within the financial statements audit practice is emerging. Practitioners follow these developments with great interest, as early experiences in applying these

techniques have uncovered the potential to generate great effectiveness and efficiency benefits over traditional methods applied to obtain an understanding of business processes, identify internal controls embedded in those processes, and test the design effectiveness of that composition. For example, auditors are traditionally used to apply a mix of techniques such as inquiry of appropriate personnel, observation of the auditee's operations and inspection of relevant documentation to obtain the aforementioned understanding. In general, this is a time-consuming manual process (Jans et al., 2010) of which the outcomes not always turn out to describe 'the whole truth'. By providing the auditor access to a larger population of business process metadata, or even a whole population, requiring assurance on absence of data omissions, process mining is believed to complement and sharpen this picture and create opportunities for auditors to better direct their audit efforts towards identified transaction risk profiles.

An example from practice (1)

The auditee is an international B2C retail organization with 1000+ stores in various European countries. Historically, the auditor has obtained the following understanding of (part of) the purchase-to-pay process, by applying audit techniques, such as inquiry of appropriate personnel, observation of the auditee's operations and inspection of relevant documentation (including the auditee's design of the process):

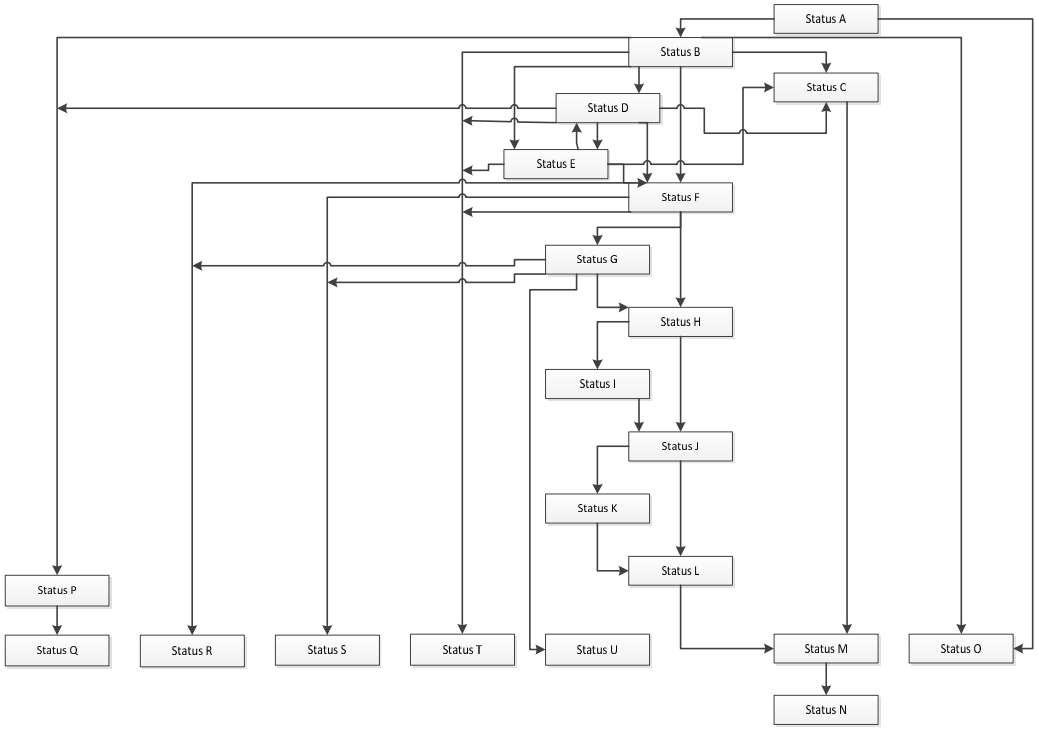

Figure 1: Understanding (part of) the purchase-to-pay process, obtained by exclusively applying 'traditional' auditing techniques

As part of the current year's audit, the auditor decides to apply process discovery, using solely event logs covering the same (sub)process, i.e. without any other 'a priori' information. Process discovery results in the following understanding of (part of) the purchase-to-pay process:

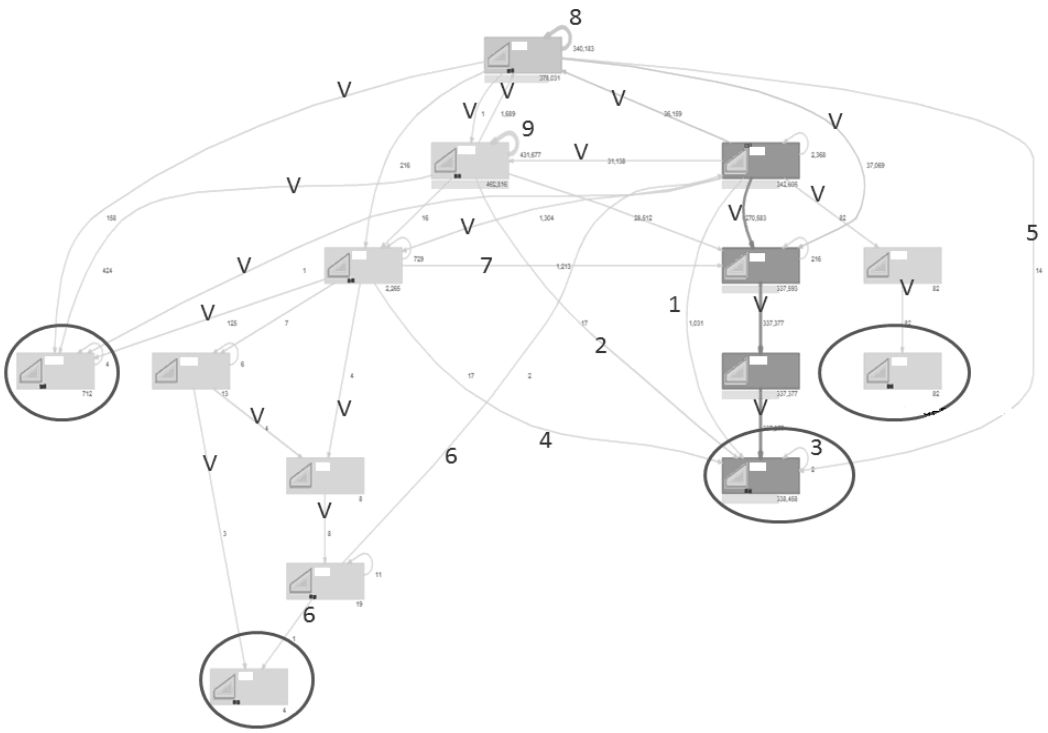

Figure 2: Outcomes of process discovery on (part of) the purchase-to-pay process

V = *Transaction flow in accordance with understanding based on inquiry of appropriate personnel, observation of the auditee's operations and inspection of relevant documentation*

Ref number = *Transaction flow additionally identified by applying process discovery*

The process discovery outcomes (figure 2) are set off against the historically obtained understanding (figure 1). The deviations in transaction flows are numbered by the auditor and further audit procedures are performed on these flows, taking materiality levels into account. These deviations represent transaction flows (paths) of which the auditor as well as the auditee's process owners had been previously unaware. The auditee uses the sharpened insights to realize further improvements in the process design and to update the organizational process flow charts (design).

Based on the evaluation of the described data-driven audit approach, the auditor and the auditee indicate to have experienced an increase in audit effectiveness, efficiency (auditor) and relevance (auditee), compared to the historically applied audit approach.

Big Data

Big Data, in the auditing context, represents the revolutionary volume, variety and velocity (three 'V's') of data (IBM, 2013) within today's auditing environment. Gartner (as cited in Vasarhelyi, 2013) explains Big Data as data that ''exceeds the reach of commonly used hardware environments and software tools to capture, manage, and process it within a tolerable elapsed time for its user population". In addition to this volume characteristic, Big Data is about data becoming more diverse as a result of a phenomenon referred to as 'datafication'. Datafication constitutes the capability to capture in data previously unmeasured aspects of the business environment (Mayer-Schönberger et al., 2013). Finally, the third 'V' refers to the (near) real-time creation and availability of organizational data, resulting from the increasing penetration of information technology and network- and system connectivity within organizations and their processes (AICPA, 2008).

Whereas CAATs and process mining are principally based on the inner data of the auditee, Big Data is about the context in which organizations operate (the outer data).

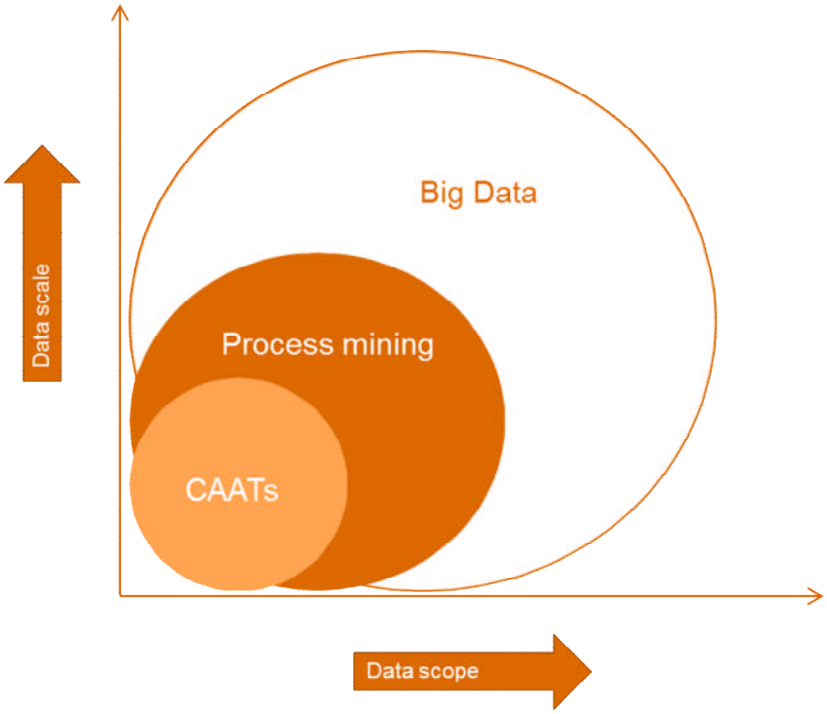

Figure 3: Data analytics developments in financial statements audit perspective

With the application of CAATs and process mining, auditors historically have been and are performing their audit procedures on (a subset of) the inner, (semi-)structured data of the auditee. With the advent of Big

Data, however, data scale and data scope increase (see figure 3) and questions rise with respect to opportunities to:

- Use outer (un)structured data within the financial statements audit
- Apply analysis techniques within the financial statements audit, that enable exploitation of knowledge embedded in the data itself, rather than techniques with previously programmed risk indicators.

Opportunities for reengineering the audit production process

The recent developments set out in this paragraph illustrate new ways external and internal auditors have come to interact with assurance information in a digital environment and some of the research efforts exploring further opportunities in this respect. Part of these research efforts are aimed at examining *to what extent the traditional audit process, as we have known it for decades, would require 'reengineering' in order to integrate the opportunities of a digitized environment in the financial statements audit to the fullest.* And, secondly, *whether the current auditing standards context is sufficient of a basis to support such level of innovation in a historically strongly regulated profession*. The next chapters will look into these two questions.

3. Opportunities for reengineering the audit production process

As described in the previous chapter, the auditor's interaction with assurance information has undergone some radical changes within quite a short time frame. The possibilities now to easily oversee and analyze an entire population of audit data and to have access to the metadata surrounding these data (which can provide behavioral feedback with respect to the audit data concerned), has re-drawn attention to the concept of 'comprehensive coherence testing' as part of Dutch auditing theory. The Dutch contribution to auditing theory (Blokdijk et al., 1995) recognized a value cycle linking the traditional accounting cycles in the financial statements, by making use of the logical and circular flow of values. As a consequence, the output of one cycle is the starting point for the next cycle. Blokdijk used the term coherence testing, defined as a procedure '(…) whereby known relationships between two or more classes of transactions and/or account balances are used' (Blokdijk et al. (1995),. p.48). In addition, Blokdijk introduced the term 'comprehensive coherence testing' for 'relationships that exist within and between the flows of goods and the flows of cash values' (Blokdijk et al. (1995), page 49), being visualized in figure 4.

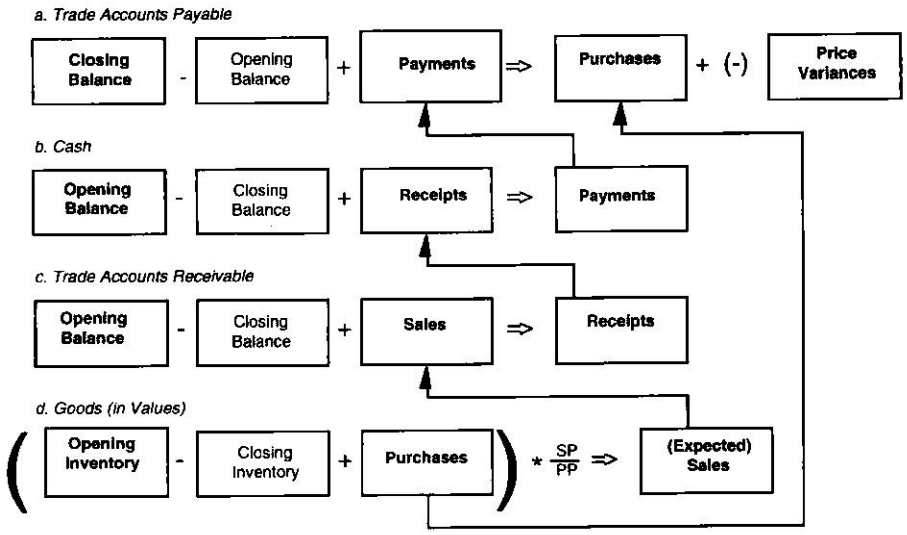

Figure 4: Model of the Flow of Goods and Cash Values in the accounting records of a trading company

Source: Blokdijk et al. (1995)

The revival of the concept of (comprehensive) coherence testing seems to lie in the necessity to develop audit hypotheses when applying data analytics with programmed risk indicators. Audit hypotheses describe

the expected behavior of cases or transactions within an audit population, taking into account audit risk indicators. Early adoptions of data analytics in audit practice show that coherence testing is, as yet, performed on a process or subprocess level. These experiences, however, do give rise to the question whether this fragmented application of coherence testing can be extended to comprehensive coherence testing, thereby evolving towards a 'model-based data enabled' approach to auditing. Such approach is founded on the concept of a comprehensive 'closed circuit' in financial administrations (because of double-entry bookkeeping) and aimed at leveraging contemporary information-technological developments, both in audit clients' environments as well as in the auditor's environment itself.

Example from practice (2)[3][4]

The auditee is a B2B trade company that imports trademarked household devices, supplied by four unique external factories. Once a year, the company organizes a full stock taking, including a proper follow-up of counting differences. Every quarter the company confirms the purchase transactions (in volumes and values) and accounts payable balances with its suppliers. The company uses a yearly product catalogue containing fixed prices for its (wholesale) customers. There is sufficient segregation of duties between authorization, custody, recording, checking and execution. Above elements are embedded in the ERP system used by the company.

The auditor leverages his understanding of the client's processes using the value cycle concept. He ensures that timeliness, accuracy and completeness of sales using the equations between the purchase and inventory cycles in volumes as well as values are reflected in the design of the ERP system.

With this understanding, the auditor leverages on the certainties in the purchase and inventory cycles and will focus his revenue testing on the margin analysis per customer and product, because accuracy, completeness and cut-off assertions have already been covered taking the other cycles into account for the cost of sales as well as the volume component in the sales.

[3] This example shows a simplified situation, disturbing elements in practice will cause specific risks to be covered additionally.

[4] Similar examples in other industries are plausible, such as professional services and constructions companies (revenues geared by timesheets and external expenses), real estate companies and social housing institutions (asset portfolio vs rental revenues), insurance companies, production companies (similar to the margin element at trade companies with the value change in production phase).

If the described model-based data enabled audit approach were to become feasible, this could place serious question marks at the effectiveness of the traditional audit process, that has been based on the historically present constraints of interaction with assurance information. In addition, the model-based data enabled audit approach seems to give rise to the need for redefinition of the level of audit evidence gained with (modern) audit procedures (Titera, 2013):

Figure 5: Redefining the level of audit evidence gained from data analytics

Source: Titera (2013)

Finally, the question is how assurance levels (i.e. reasonable, limited) are impacted by this modern approach to coherence testing using an entire population of (relevant) data, and what this approach does to the inherent limitations of an audit. The next chapter will have a further look into the methodological aspects of a data enabled audit.

Example from practice (3)

Using equations, the auditor may reflect tendencies identified in the understanding phase of the audit related to understatement or overstatement of profits. This distinction is mentioned as 'owner ordered auditing' versus 'management ordered auditing' (Weigand & Elsas, 2012;. Blokdijk 1995). In owner ordered auditing, the principal's *primary* interest is completeness of ROI (Return On Investment), thus addressing *understatement of profits*, whether revenues are understated or expenses are overstated (Weigand & Elsas 2012). More recently, the technology is being positioned for incorporation into software for assurance and monitoring of the franchisor/franchisee relationship by ZeeZor, a company based in Atlanta. In addition to the value gained in this sector by franchisor ordered audits, several tax authorities, including The Netherlands and the State of Georgia in the USA have initiated programs.

4. Auditing Standards considerations: evolution or revolution?

Effects on the concept of reasonable assurance

With the Clarity project ended in 2009 as the latest major revision of the International Standards on Auditing (ISAs), the International Auditing & Assurance Standards Board (IAASB) reformulated and redefined the principles of auditing with clear objectives, requirements to reach the objectives and application material to guide the auditor when fulfilling these requirements. Nevertheless, the overall objective of an audit basically remained the same as 'To obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, thereby enabling the auditor to express an opinion on whether the financial statements are prepared, in all material respects, in accordance with an applicable financial reporting framework (…) (ISA 200. 11a), whereas reasonable assurance was rephrased as '(…) a high, but not absolute, level of assurance' ISA 200.13m). The absence of absolute assurance as compared to reasonable assurance is due to the inherent limitations of an audit. ISA 200 defines four sources of inherent limitations: the nature of financial reporting; the nature of audit procedures; the need for the audit to be conducted within a reasonable period of time and at a reasonable cost; and the nature of financial reporting (ISA 200.A45). In the context of the ISA adoption process in the EU, The European Federation of Accountants (FEE, 2007) stratified these inherent limitations in two main categories: a) limitations that are beyond the auditor's control, and b) limitations of which the auditor has some influence or control. Inherent limitations that are beyond the auditor's control are for instance a side letter for a contract not yet reflected in the bookkeeping and not being made available at all to the auditor. Examples of inherent limitations on which the auditor has some influence or control include the auditor's choice to perform controls testing, analytical procedures and sampling, but inherent to those procedures, the auditor does not cover the full population. The level of assurance may vary across financial statement line items as well as assertions (see figure 6). For instance: accuracy of the bank balances may have an (almost) 100% assurance checking the amount with the original banks statement, but completeness may result in a lower level of assurance due to the absence of the ability to be certain that all bank accounts have been reflected in the bookkeeping.

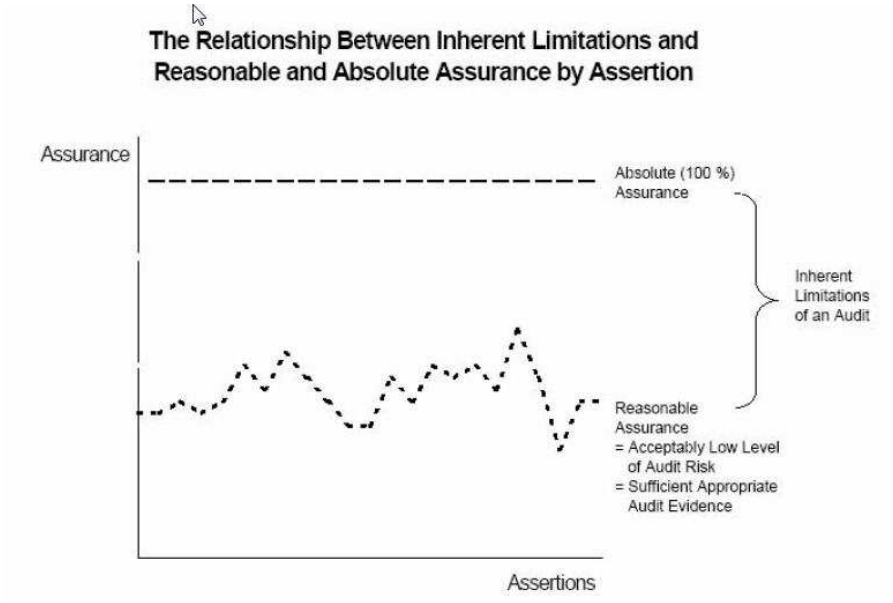

Figure 6: the relationship between inherent limitations and reasonable and absolute assurance by assertion

Source: FEE (2007), p. 13

With the extended use of data analytics full populations can be covered, which potentially decrease the inherent limitations of the audit and consequently may increase the level of assurance.

Effects on the concepts of risk and response

As described in the previous chapters, data analytics can be used in various stages of the audit. Specifically it contributes to understanding the client's processes (ISA 315), to the evidence gathering phase (ISA 330, 500 and further) of the audit, as well as to the communication with management and those charged with governance. In order to be able to issue an opinion on the financial statements, the auditor is required to perform a due process comprising the identification and assessment of the risk of material misstatement (ISA 315) and responding to assessed risks (ISA 330). In order to be as complete as possible for the identification and assessment of the risk of material misstatement, ISA 315 requires the auditor to have a comprehensive risk analysis, including understanding of the entity and its environment, including the entity's internal control. As part of the internal control, the auditor has to assess the control environment, the entity's risk assessment, its information system including the related business processes relevant for financial reporting and communication, controls activities relevant to the audit and monitoring of controls. Related to the evolving data developments, as described in chapter 2 of this paper, especially the elements of understanding the information system and the business processes are relevant.

Based on this thorough risk analysis, the auditor has to decide which audit procedures he will use to mitigate the risks of material misstatement. In general, he can choose to perform test of controls and/or substantive audit procedures (ISA 330.4). Test of controls are required when he wants to rely on the effectiveness of the controls (ISA330.8a), or when substantive procedures alone cannot provide sufficient appropriate audit evidence (ISA 330.8b). ISA 330 requires the auditor to perform substantive audit procedures at least for each material class of transactions, account balance, and disclosure (ISA 330.18), related to the financial statement closing process (ISA 330.20), and related to significant risks (ISA 330.21).

The use of data that goes beyond CAATs, questions whether process mining, especially the category 'conformance checking' is a system-based or substantive audit procedure. This is relevant as the auditor is required to perform substantive audit procedures at least for each material class of transactions, account balance, and disclosure (ISA 330.18). In our view, this is a dual purpose test in accordance with ISA 330.A23): the process mining is a reperformance of the control over the whole population - except for that part where deviations are notified -, but is also a substantive audit procedure as the auditor creates his own acceptable range boundaries taking into account the nature of the flow of goods or services. In addition, reperformance of controls over the whole population decreases the controls testing and sampling risk, and therefore decrease the inherent limitations of an audit.

Effects on reliability of information used as audit evidence

ISA 500 indicates 'The reliability of information to be used as audit evidence (…) is influenced by its source and its nature, and the circumstances under which it is obtained, including the controls over its preparation and maintenance where relevant. '(ISA 500.A31). The same article in this standard provides presumptions about the reliability of audit evidence. Table 1 summarizes these indications and reflects the consequences in a data rich audit process.

Data reliability indication in the ISAs **Source: ISA 500.A31**	**Effects for reliability in a data rich audit**
The reliability of audit evidence is increased when it is obtained from independent sources outside the entity.	Increases when the auditor is using external confirmation on key equations.
The reliability of audit evidence that is generated internally is increased when the related controls, including those over its preparation and maintenance, imposed by the entity are effective.	Increases when key controls related to the flow of goods and services are embedded into the ERP system, the raises.
Audit evidence obtained directly by the auditor (…)	Increases when the auditor designs the equations.
Audit evidence in documentary form, whether paper, electronic, or other medium, is more reliable than evidence obtained orally (…).	Increases as the auditor primarily observes the actual goods/services movements rather than reading documentation and performing walkthrough test for the understanding of the design of the controls.
Audit evidence provided by original documents is more reliable than audit evidence provided by photocopies or facsimiles, or documents that have been filmed, digitized or otherwise transformed into electronic form, the reliability of which may depend on the controls over their preparation and maintenance.	Unclear in a digitized environment when original (paper) documents are becoming more and more absent.

Table 1: Digitalization effects on data reliability

5. Areas for further Research

The developments described in this paper give a number of opportunities to enhance the added value of audit research for audit practice.

Feasibility of model based data enabled audit

Following the questions raised in chapter 3, there are opportunities to research the technical, methodological, economical and societal feasibility of a model based data enabled audit. This research area allows exploration of the effectiveness of traditional audit approaches and procedures and opportunities for reengineering thereof.

Central place for normative audit models, per type of business

Following the process mining developments described in chapter 2, auditors need to evaluate the ‘As Is’ situation of a process flow as compared to a ‘To Be’ situation. If that is the case, the auditor may use this as audit evidence using the comprehensive coherence testing. Key question is ‘what is “good” here?’ Practitioners may take a lead in developing normative / guidance audit equation models per type of business, academics may conduct empirical studies of the application of audit equation models and publish about it, just like in the introduction of a new medicine.

Build and execute audit models in online audit instruction market: apply Pacioli Domain-Specific Language, key result of “Next generation Auditing” project

This activity is required for the industry-expert auditor who builds an audit equation model for a specific type of business or industry. Once such a model is ready, or at least a version of it, it is uploaded and made available for downloads by audit engagement teams, who execute it as guidance.

Exploring the effects of digitization on the level of assurance

Following paragraph 4, further research is needed to explore the effects of digitization on the level of assurance, for inherent limitations beyond control of the auditor (using the potential when using big data) as well as for inherent limitations over which the auditor has some influence or control replacing manual substantive and controls testing as a sample by data equations over the entire population.

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